



**Final Human Health Risk Assessment  
Area of Concern 4 (AOC-4)**

**Remedial Investigation/Feasibility Study**

**Falcon Refinery Superfund Site  
Ingleside, Patricio County, Texas  
EPA Identification No. TXD086278058**

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## LIST OF ACRONYMS AND ABBREVIATIONS

$\mu\text{g/L}$	Microgram(s) per liter
$\mu\text{g/m}^3$	Microgram(s) per cubic meter
$\mu\text{g/mg}$	Microgram(s) per milligram
ABS	Absorption factor
ADAF	Age-dependent adjustment factor
ADI	Average daily intake
AF	Adherence factor
AOC	Area of Concern
AST	Above ground storage tank
AT	Averaging time
BW	Body weight
CF	Conversion factor
$\text{cm}^2$	Square centimeter(s)
$\text{cm}^3$	Cubic centimeter(s)
COPC	Chemical(s) of potential concern
CR	Ingestion rate
CSM	Conceptual site model
DAD	Dermal absorbed dose
$\text{DA}_{\text{event}}$	Dermal absorbed dose per event
DAF	Dosimetric Adjustment Factor
DFS <sub>Madj</sub>	Mutagenic dermal contact factor
EA	EA Engineering, Science, and Technology, Inc.
EC	Exposure concentration
ED	Exposure duration
EF	Exposure frequency
EPA	U.S. Environmental Protection Agency
EPC	Exposure point concentration
ERG	Environmental remedial goal
ET	Exposure time
FM	Farm-to-Market
FOD	Frequency of detection
FS	Feasibility Study
GIABS	Gastrointestinal dermal absorption factor

**LIST OF ACRONYMS AND ABBREVIATIONS (continued)**

HEC	Human Equivalent Concentration
HHRA	Human Health Risk Assessment
HI	Hazard index
HQ	Hazard quotient
IEUBK	Integrated Exposure Uptake Biokinetic Model
IFSMadj	Mutagenic Ingestion Rate
IRIS	Integrated Risk Information System
IUR	Inhalation Unit Risk
kg	Kilogram(s)
kg/mg	Kilogram(s) per milligram
L	Liter(s)
L/day	Liter(s) per day
LADI	Lifetime average daily intake
LEC <sub>10</sub>	10 percent response level concentration
LOAEL	Lowest observed adverse effect level
MCL	Maximum contaminant level
mg/cm <sup>2</sup>	Milligram(s) per square centimeter
mg/day	Milligram(s) per day
mg/kg	Milligram(s) per kilogram
mg/kg-BW/day	Milligram(s) per kilogram body weight per day
mg/kg/day	Milligram(s) per kilogram per day
mg/L	Milligram(s) per liter
mg/m <sup>3</sup>	Milligram(s) per cubic meter
NCP	National Contingency Plan
NOAEL	No observed adverse effect level
NORCO	National Oil Recovery Corporation
PAH	Polycyclic aromatic hydrocarbon
PEF	Particulate emission factor
RAGS	Risk Assessment Guidance for Superfund
RfC	Reference concentration
RfD	Reference dose

**LIST OF ACRONYMS AND ABBREVIATIONS (continued)**

RI	Remedial Investigation
RL	Reporting limit
RME	Reasonable maximum exposure
RSL	Regional screening level
SA	Surface area
SF	Slope factor
Site	Falcon Refinery Superfund Site
SPMWD	San Patricio County Municipal Water District
TCEQ	Texas Commission on Environmental Quality
TDLR	Texas Department of Licensing and Regulation
TDS	Total Dissolved Solids
UCL	Upper confidence limit on the mean
UF	Uncertainty factor

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## **1. INTRODUCTION**

EA Engineering, Science, and Technology, Inc. (EA) has been authorized by the U.S. Environmental Protection Agency (EPA), under Remedial Action Contract Number EP-W-06-004, Task Order 0088-RICO-06MC, to conduct a Remedial Investigation/Feasibility Study (RI/FS) at the Falcon Refinery Superfund Site (Site). EPA's scope of work includes the preparation of a human health risk assessment (HHRA) for the Site. EPA has requested that EA prepare a HHRA for the barge dock area (Area of Concern 4 [AOC-4]) and the Intracoastal Waterway (AOC-5) separate from the remaining Site. This document provides the results of the HHRA for AOC-4.

The HHRA is an integral part of the remedial investigation (RI) process included in the Oil and Hazardous Substance National Contingency Plan (NCP) (40 Code of Federal Regulation 300.430) pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (42 U.S. Code 9605). The risk assessment estimates the potential risk and hazard to potential human receptors for exposure to media affected by past activities related to the Site.

### **1.1 SITE HISTORY**

The Site is located 1.7 miles southeast of State Highway 361 on Farm-to-Market (FM) 2725 at the north and south corners of the intersection of FM 2725 and Bishop Road near the City of Ingleside in San Patricio County, Texas (Figure 1). The Site occupies approximately 104 acres and consists of a refinery that operated intermittently and has not produced hydrocarbon products in several years. The refinery is currently inactive, except for a crude oil storage operation being conducted by Superior Crude Gathering, Inc. When in operation the refinery had a capacity of 40,000 barrels per day and the primary products consisted of naphtha, jet fuel, kerosene, diesel, and fuel oil. The refinery also historically transferred and stored vinyl acetate, a substance not excluded under the petroleum exclusion.

The Site is divided into the North Site, South Site and current barge dock facility. There are pipelines that connect the North and South Sites with the current and former barge dock facilities. The North Site consisted of nine above ground storage tanks (ASTs), three truck loading racks, associated piping, and a transfer pump. The South Site consisted of the main operations of the refinery. This area had a control room, heaters, crude towers, coalescers, boilers, fire water tank, exchangers, cooling towers, desalters, exchangers, compressors, a lab, 24 ASTs, separator, clarifiers, and aeration pond (TRC 2013). The barge dock facility is located on Redfish Bay and was used to load and unload crude oil and refined hydrocarbons via pipelines that connect the dock to the North and South Sites.

The Site was proposed to the National Priorities List on September 5, 2002. The Potentially Responsible Party for the Site, National Oil Recovery Corporation (NORCO), entered into an "Administrative Order on Consent" with the EPA on 9 June 2004, to perform and finance the removal action and RI/FS for the Site.

In 2012, NORCO sold the former Falcon Refinery to Lazarus Texas Refining I, LLC (Lazarus), which operates the former refinery as a crude oil bulk storage and transfer facility. Lazarus is attempting to obtain a notice of no further action for the barge dock facility to obtain a “bridge loan” until additional funding can be obtained (TRC 2013). Lazarus plans to further develop the Site through remedial actions and upgrades.

The Site has been divided into AOCs based upon former use and location (Figure 2). AOC-1 consists of the Former Operational Units and includes the entire North Site and a drum disposal area and metal waste disposal area of the South Site. AOC-2 includes areas of the refinery that were not used for operations or storage and have no record of releases. AOC-3 encompasses the wetlands immediately adjacent to the Site that are bordered by Bay Avenue, Bishop Road, and a dam on the upstream side; wetlands located between Bishop Road, Sunray Road, Bay Avenue, and residences along Thayer Avenue; and the wetlands between Sunray Road, residences along FM 2725, Gulf Marine Fabricators, Offshore Specialty Fabricators, and the outlet of the wetlands into Redfish Bay. Within AOC-3, there are one active and several abandoned pipelines that lead from the refinery to the barge dock facilities. During June 2006, the abandoned pipelines were cut, the contents of the pipelines were removed, and plates were welded on the pipelines. AOC-4 includes the barge docking facility. AOC-4 is approximately 0.5 acres and is located on Redfish Bay. The fenced facility, which is connected to the refinery by pipelines, is used to load and unload barges. Currently only crude oil passes through the docking facility. Historically, refined products were also loaded and unloaded. AOC-5 encompasses the sediments and surface water within the Intracoastal Waterway adjacent to the barge dock facility. AOC-6 includes the neighborhood along Thayer Road, across from the refinery. AOC-7 includes the neighborhood along Bishop Road, across from the North Site.

## **1.2 SITE INVESTIGATIONS**

Phase I sampling was conducted at the Site in 2007 by the Potentially Responsible Parties. EA conducted Phase II investigation activities in accordance with the Field Sampling Plan (EA 2012a) and Quality Assurance Project Plan (EA 2012b) under this task order in 2013.

## **1.3 OBJECTIVE**

The overall objective of this HHRA is to evaluate potential human health risk under current and potential future conditions at AOC- 4. Specifically, the HHRA presents the following objectives:

- Outline the regulatory basis and guidance for conducting the HHRA
- Outline the methods for determining chemical(s) of potential concern (COPC) for the HHRA
- Present the exposure setting for the site that details local land use, nearby human populations, and potential site activities

- Develop a conceptual site model (CSM) that characterizes relevant contaminant pathways and receptors of concern
- Calculate potential carcinogenic and non-carcinogenic risk to receptors of concern (e.g., any human contact at the site under present or future scenarios)
- Identify areas or media that pose no unacceptable risks to human health and require no further action
- Determine COPC that contribute significantly to overall site risks, which will be used to determine risk-based preliminary remediation goals in the FS
- Provide baseline risks for the no-action alternative in the FS that are used to evaluate risk reduction for each proposed alternative.

#### **1.4 GENERAL HUMAN HEALTH RISK ASSESSMENT APPROACH**

The HHRA follows guidance as recommended by EPA. Specific application of guidance throughout the risk assessment process is detailed in Section 2 of this document. The following guidance documents were used for this HHRA:

- Risk Assessment Guidance for Superfund (RAGS), *Volume I: Human Health Evaluation Manual (Part A) (Interim Final)*, EPA/540/1-89/002 (EPA 1989)
- RAGS, Volume I: Human Health Evaluation Manual Supplemental Guidance – *Standard Default Exposure Factors* (Interim Final), Publication 9285.6-03 (EPA 1991a)
- RAGS, Volume I – Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals). EPA/540/R-92/003. December. (EPA 1991b)
- *Guidelines for Data Usability in Risk Assessment (Part A)*. Office of Solid Waste and Emergency Response, Publication OSWER9285.7-09A (EPA 1992)
- *Exposure Factors Handbook*, Volumes I, II, and III (EPA 1997a)
- RAGS, Volume I: Human Health Evaluation Manual (Part D, Standardized Planning, Reporting and Review of Superfund Risk Assessments). Office of Emergency and Remedial Response (EPA 2002a)
- *Human Health Toxicity Values in Superfund Risk Assessments*. OSWER9285.7-53. Office of Emergency and Remedial Response (EPA 2003)

- *RAGS, Volume I: Human Health Evaluation Manual (Part E: Supplemental Guidance for Dermal Risk Assessment)* Final, EPA/540/R/99/005, OSWER9285.7-02EP, Office of Superfund Remediation and Technology Innovation, July (EPA 2004)
- *Guidelines for Carcinogen Risk Assessment*. Risk Assessment Forum. EPA/630/P-03/001F (EPA 2005a)
- Supplemental Guidance for Assessing Susceptibility From Early-Life Exposure to Carcinogens. Risk Assessment Forum, EPA/630/R-03/003F (EPA 2005b)
- Risk Assessment Guidance for Superfund. Volume I: Human Health Evaluation Manual (Part F: Supplemental Guidance for Inhalation Risk Assessment) Final. Office of Superfund Remediation and Technology Innovation, EPA-540-R-070-002 (EPA 2009a)
- *Exposure Factors Handbook, 2011 Edition*. EPA/600/R-090/052F (EPA 2011)
- Regional Screening Levels (RSLs) for Chemical Contaminants at Superfund Sites. Available at: [http://www.epa.gov/reg3hwmd/risk/human/rb-concentration\\_table/index.htm](http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/index.htm). November (EPA 2013a).

## **2. HUMAN HEALTH RISK ASSESSMENT METHODOLOGY**

The purpose of this HHRA is to evaluate potential human health concerns from exposure to environmental media within AOC-4 that have been affected by past activities. To determine human health concerns, the HHRA evaluates potential sources of contamination and routes of migration based on current and potential future site uses. The HHRA results are based upon potential exposure pathways that can occur or are reasonably likely to occur in the future. Risks determined in the HHRA are considered baseline risks associated with exposure to media affected by the site. The baseline risk assumes no remedial actions or other means of exposure reduction (i.e., the use of personal protective equipment, digging restrictions, etc.). The HHRA evaluates the reasonable maximum exposure (RME) that has the potential to occur at the site. Therefore, HHRA results are considered potential and should be used as a guideline in making risk management decisions.

Following EPA guidance (EPA 1989), the HHRA methodology involves a four-step process: data evaluation and hazard assessment, exposure assessment, toxicity assessment, and risk characterization. The following sections detail each step.

### **2.1 DATA EVALUATION AND HAZARD ASSESSMENT**

In the data evaluation and hazard assessment, available environmental data were compiled and reviewed. The site environmental data are analyzed for data quality and compared to risk-based screening values. The comparison to risk-based screening values allows the HHRA to focus on analytes that may contribute significantly to overall sites risks. Analytes that are below risk-based screening values are below a level that is not considered a concern for human health and do not require further evaluation.

#### **2.1.1 Data Included in the Human Health Risk Assessment**

Initial field sampling was conducted in 2007 as a result of an EPA approved RI/FS Field Sampling Plan and Quality Assurance Project Plan for the former refinery, adjacent properties, and background sampling locations (TRC 2013). Analytical data obtained during the sampling was evaluated for ecological exposures, and results indicated that further sampling was necessary to adequately assess certain portions of the Site. Field activities conducted in 2013 as part of the Phase II Field Sampling Plan had objectives relating to this HHRA which included providing data to identify and delineate the extent of COPCs in environmental media, identify potential and complete exposure pathways, and provide data for completion of human health and ecological risk assessments as well as the FS. Appendix A presents the samples collected that were used in this risk assessment. Sample locations are presented in Figure 3.

A total of six surface soil and twelve subsurface soil samples were collected from AOC-4 in 2008 and 2013 as shown in Figure 3. For the purposes of the HHRA, surface soil is defined as the top 0 to 6 inches below ground surface. Typically, the construction of buildings and associated utilities would require the mixing of surface soil and subsurface soil. The analytical results and the risk-based screening results were reviewed before surface soil and subsurface soil

results were combined to represent a total soil media. Surface soil analytical results were typically higher and resulted in more COPCs identified than subsurface soil. Therefore, surface soil and subsurface soil were evaluated separately. Only one ground water sample was collected from MW-17. Due to the limited number of ground water sample results, ground water is only evaluated qualitatively in relation to the EPA tap water RSL. Both the soil and ground water were analyzed for target analyte list (TAL) metals, polycyclic aromatic hydrocarbons (PAHs), semivolatile organic compounds (SVOCs), and volatile organic compounds (VOCs).

Investigation of soil for the Site included collection and analysis of samples from 10 locations representative of background conditions. These locations were selected to be beyond the suspected influence of the Falcon Refinery Site. Background data are evaluated in the HHRA in the Uncertainty Section to aid in risk management decisions. Sample locations and sample results for the background samples are provided in Tables B-1 through B-3 in Appendix B.

ProUCL 5.00.00 (EPA 2013a) was used to determine an upper prediction limit (UPL). The UPL was selected based upon a decision tree that takes into account the frequency of detection. The decision tree is provided in Appendix B. ProUCL outputs are summarized in Table B-4 of Appendix B.

### **2.1.2 Data Quality Evaluation**

The inclusion or exclusion of data within the HHRA on the basis of analytical qualifiers was performed in accordance with EPA guidance (EPA 1989, 1992). The following procedures were followed if qualifiers were present:

- Analytical results bearing the U- qualifier (indicating that the analyte was not detected at the given reporting limit [RL]) were retained in the data set and considered non-detects at the given RL.
- Analytical results for organic and inorganic analytes bearing the J- qualifier (indicating that the reported value was estimated because the analyte was detected at a concentration below the RL or for other reasons) and L- qualifier (indicating the reported value may be biased low) were retained at the reported concentration.
- Inorganic analytical results bearing the B- qualifier (indicating the analyte was detected between the method detection limit and the RL) were retained at the reported concentration.

If duplicate samples were collected or duplicate analyses were conducted on a single sample, the following guidelines were employed to select the appropriate sample measurement:

- If both samples/analyses show that the analyte was present, the maximum detected concentration of the two results was retained in the dataset.

- If both samples/analyses show no detect values, the maximum of the two non-detect RLs was retained in the dataset.
- If only one sample/analysis indicated that the analyte was present, it was retained in the dataset and the non-detect value was discarded.

Laboratory quality control samples, spikes, and blanks were not included in the HHRA. The frequency of detection (FOD) is based on the number of detected concentrations out of the total number of samples. Since samples were sometimes analyzed for different sets of analytes, the total number of samples used in calculation of the FOD may vary by analyte.

### 2.1.3 Risk-Based Screening

Risk-based screening was conducted by comparing maximum detected analyte concentrations to risk-based screening concentrations. Any analyte in any medium for which the maximum measured concentration exceeded the risk-based screening concentration was retained as a COPC.

The EPA RSLs (EPA 2013a) were used for risk-based screening purposes in the HHRA. The EPA RSLs combine human health toxicity values with “standard” exposure scenarios to estimate analyte concentrations in environmental media that are considered by the EPA to be protective of human exposures (including sensitive populations), over a lifetime. For instance, a residential scenario assumes a standard exposure of 350 days per year over a 30-year duration. The screening values are based on specific, conservative, fixed levels of risk. For carcinogens, this is  $10^{-6}$ , which is the lower bound for excess lifetime potential carcinogenic risk as defined by the NCP (EPA 1990). For non-carcinogens, the screening values are based on a hazard quotient of 1.0. To account for potential cumulative effects of multiple contaminants affecting the same target organ, one-tenth of the acceptable non-carcinogenic threshold was used for screening. The EPA RSL table identifies some carcinogenic contaminants where the carcinogenic RSL is greater than one-tenth the non-carcinogenic RSL (identified in the EPA RSL tables as “c<sup>\*\*</sup>”). In these instances, the more conservative one-tenth the non-carcinogenic RSL was used.

Essential nutrients (calcium, magnesium, potassium, and sodium) were eliminated from consideration on the basis of their essential nutrient status. Essential nutrients were not compared to risk-based screening values.

Ground water analytical results were compared to the EPA tap water RSL. Lead is identified as a non-carcinogenic compound in the EPA RSL table. However, the lead RSL was not modified by one-tenth because the lead RSL is based upon blood-lead modeling and not actual toxicity values. The maximum detected lead concentration in ground water was compared to the EPA maximum contaminant level (MCL) of 15 micrograms per liter ( $\mu\text{g/L}$ ) for lead in residential and public drinking water (EPA 2009b).

For total chromium, risk-based screening values assumed trivalent chromium. Surrogate compounds were determined for detected analytes that lack specific RSL values. For example,

the non-carcinogenic PAH pyrene was used as a surrogate for the non-carcinogenic PAH benzo(g,h,i)perylene. Surrogate compounds were identified on the basis of similarity in chemical structure and toxic properties. The example listed above demonstrates this process; a surrogate non-carcinogenic PAH was chosen to represent other non-carcinogenic PAHs that lack RSL values. Each screening table notes which surrogates were used in the screening process.

Background concentrations are presented for surface soil, subsurface soil, and ground water. Figure 4 presents the location of the background samples. Background levels are presented for comparison purposes only and were not part of the COPC selection process. A comparison to background concentrations is presented in the Uncertainty Section (Section 3.1).

## **2.1.4 Analytes Exceeding Risk-Based Screening Levels**

### **2.1.4.1 COPCs in Surface Soil**

The following COPCs in surface soil (Table 1) were identified based on the residential soil RSL risk-based screen: aluminum, arsenic, cobalt, iron, manganese, mercury, benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene.

### **2.1.4.2 COPCs in Subsurface Soil**

The following COPCs in subsurface soil (Table 2) were identified based on the residential soil RSL risk-based screen: arsenic, mercury, benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene.

### **2.1.4.3 COPCs in Ground Water**

The following COPCs in ground water (Table 3) were identified based on the tap water RSL risk-based screen: total and dissolved arsenic and total and dissolved manganese.

## **2.2 EXPOSURE ASSESSMENT**

The second step of the HHRA process is the exposure assessment. In the exposure assessment, the receptors of concern and potential exposure pathways are identified. The COPC in Site environmental media are converted into systemic doses, taking into account contaminant concentrations, rates of contact (e.g., ingestion rates), and absorption rates of different COPC. The magnitude, frequency, and duration of these exposures are then integrated to obtain estimates of daily doses over a specified period of time (e.g., lifetime, activity-specific duration).

The exposure assessment includes several steps:

- Evaluating the exposure setting, including a description of the land uses and the potentially exposed human populations
- Developing the CSM identifying the source of contamination, contamination transport and release mechanisms, exposure media, exposure routes, and potentially exposed populations

- Calculating exposure point concentrations (EPCs) for each COPC for each of the complete exposure pathways identified in the CSM
- Identifying the exposure models and parameters with which to calculate the exposure doses
- Calculating exposure doses.

### 2.2.1 Exposure Setting

AOC-4 is approximately 1.7 acres and is located on Redfish Bay. The fenced facility, which is connected to the refinery by pipelines, is used to load and unload barges. AOC-4 is surrounded by other industrial facilities and storage areas. Residents are located approximately 0.5 miles to the northwest. Currently only crude oil passes through the docking facility. Historically, refined products were also loaded and unloaded. The barge dock facility (AOC-4) contains a dock and several small structures to load and unload crude oil. There have been no known spills or releases within AOC-4.

Although there is no indication from the boring cores that fill material is present at the Site, historical aerial photos show that the area generally consisted of wetlands in the 1950s. It is likely that the elevation of the Site was raised with fill material for its industrial purpose and also because of the potential for flooding and hurricanes in the area.

Based on aerial photographs and direct observation during site visits, AOC-4 is mostly barren of vegetation with scattered patches of herbaceous vegetation interspersed among the roads and storage areas. Based upon the AOC-4 setting and reports from the owner, the likely future land use is to remain industrial. AOC-4 is located outside the Ingleside city limits and is not covered under zoning ordinances. The current owner of the property, Lazarus, is operating the entire Site, including AOC-4, as a crude oil bulk storage and transfer facility (TRC 2013). Lazarus is in the process of obtaining a “bridge loan” that “will lead to employment expansion, allow further finance development of the Site including additional remedial actions and upgrades to the Site (TRC 2013).” The “bridge loan” is specifically tied to being able to use the Barge Dock Facility, AOC-4. There are no known deed restrictions for AOC-4. However, the deed for the entire Site notes the EPA has identified this Site is a Superfund Site and is subject to remediation and clean-up.

The Site is located in the San Antonio-Nueces Coastal Basin adjacent to Redfish Bay, which connects Corpus Christi Bay to the Gulf of Mexico. Surface water drainage from the Site enters the wetlands along the southeastern section of the abandoned refinery. A culvert connects the onsite palustrine/estuarine wetlands to estuarine wetlands. The wetlands then connect to the Intracoastal Waterway and Redfish Bay.

Ground water at the Site is located approximately two feet below ground surface. Based upon ground water classifications set forth by the Texas Commission on Environmental Quality

(TCEQ), ground water below AOC-4 is a Class 2 ground water. Information for total dissolved solids (TDS) is not available for ground water at the Site. Based upon information presented in the Texas Department of Licensing and Regulation's Well Report and Submission and Retrieval System, there are six ground water wells located within 1 mile of AOC-4 (TDLR 2014). This does not include monitoring wells installed to monitor the Site. One well is used as a domestic water supply, four wells are used as industrial water supplies for Gulf Marine Fabricators, and one well is used as an irrigation well. Public water supply is available for San Patricio County and is provided by the San Patricio County Municipal Water District (SPMWD), which supplies water to municipal water systems. The closest municipal water system to AOC-4 is the Ingleside Water Department. The SPMWD obtains its water supply from two reservoirs: Choke Canyon Reservoir and Lake Corpus Christi. The reservoirs are fed by the Nueces, Frio, and Atascosa Rivers. AOC-4 is not located within an identified service area.

### **2.2.2 Conceptual Site Model**

Based upon the Site history and exposure setting, a CSM was formulated for AOC- 4. The CSM presents the potential sources of contamination, routes of migration, and potential receptors. Exposure pathways begin from potential source areas and progress through the environment via various fate and transport processes to potential human receptors. Figure 5 illustrates the CSM. The CSM identifies which exposure pathways are complete and require further evaluation in the HHRA. An exposure pathway describes a mechanism by which a population or individual may be exposed to COPCs at the Site. A completed exposure pathway requires the following four components:

- Source and mechanism of chemical release to the environment
- Environmental transport medium for the released chemical
- Point of potential human contact with the contaminated medium
- Human exposure route at the point of exposure.

All four components must exist for an exposure pathway to be complete and for exposure to occur. Incomplete exposure pathways do not result in actual human exposure and are not included in the exposure assessment and resulting risk characterization.

#### **2.2.2.1 Media of Concern**

For AOC-4, media of concern include soil (surface and subsurface soil) and ground water.

#### **2.2.2.2 Receptors of Concern**

Within the exposure assessment, EPA (1989, 1991b) guidance requires that plausible exposure under both current and future land use be evaluated in the HHRA. The Site is an industrial area and the most likely future use is industrial. Residents and various businesses are located adjacent to and near the Site. As a result, current receptors include workers and trespassers. Future use of the Site is expected to remain industrial, and it is not anticipated that the Site will be used for

residential purposes. However, there are no institutional controls to prevent re-use of the Site as a residential area. Additionally, the evaluation of a residential scenario provides a baseline evaluation that identifies whether unrestricted site use is a possibility. Residential receptors of concern include a resident adult and child. Ground water sampling within AOC-4 only included results from one monitoring well. Due to the limited ground water sample results, ground water was evaluated qualitatively based upon a comparison to the EPA tap water RSLs.

The following exposure pathways are identified as complete for AOC-4:

- Ingestion of and dermal contact with ground water
- Ingestion of, dermal contact, and inhalation of particulates from surface soil
- Ingestion of, dermal contact, and inhalation of particulates from subsurface soil.

As noted, trespassers may visit the Site. Any contact by a trespasser would be infrequent and at a low contact rate. Therefore, the residential exposure to these media adequately accounts for any concerns with trespassers within AOC-4. Additionally, the construction worker provides a protective evaluation of potential risk concerns for contact with AOC-4 for all potential workers who may visit. A conceptual site model presenting pathways that were considered is provided in Figure 3.

### **2.2.3 Selection of Exposure Point Concentrations**

EPCs were derived to quantify concentrations of COPC. For the HHRA, the EPC represents the concentration of COPC in media of concern that a potential receptor is expected to contact over a designated exposure period. Reported concentrations of COPC were used to calculate the 95<sup>th</sup> percentile upper confidence limit on the mean (95UCL) in each medium of concern (EPA 1989, 1992). For calculation of the 95UCL, each non-detected analyte was assigned a numerical value equal to its RL (EPA 2013b). For U qualified data resulting from higher dilution levels, the result from the undiluted or initial run was included as the result.

The 95UCL was used because assuming long-term contact with the maximum concentration is not reasonable (EPA 1989). The 95UCL was determined through the EPA ProUCL program version 5.0.00 (EPA 2013b). The EPA ProUCL program determines the distribution, sample size, variance, and 95UCL of each COPC data set (EPA 2013b). The EPC is based on the lesser of the maximum detected concentration for a medium or the 95UCL (EPA 2013b). Outputs for the ProUCL program are presented in Appendix C.

### **2.2.4 Exposure Equations**

The next step in the exposure assessment is to estimate COPC intake or exposure for each exposure pathway considered in the HHRA. In the exposure assessment, two different measures of intake are provided, depending on the nature of the effect being evaluated. When evaluating longer-term (i.e., subchronic and chronic) exposures to chemicals that produce adverse non-carcinogenic effects, intakes are averaged over the period of exposure (i.e., the averaging time

[AT]) (EPA 1989). This measure of intake is referred to as the average daily intake (ADI) and is a less than lifetime exposure. For chemicals that produce carcinogenic effects, intakes are averaged over an entire lifetime and are referred to as the lifetime average daily intake (LADI) (EPA 1989). Detailed equations for determining intake are provided on Tables 7 through 9.

The generic equation to calculate ingestion intake from soil is given below:

$$(L)ADI = \frac{EPC \times CR \times EF \times ED \times CF}{BW \times AT}$$

where

<i>(L)ADI</i>	=	(Lifetime) Average daily intake (mg/kg/day)
<i>EPC</i>	=	Concentration of a COPC in soil (mg/kg)
<i>CR</i>	=	Ingestion Rate (milligrams per day [mg/day])
<i>EF</i>	=	Exposure frequency (days/year)
<i>ED</i>	=	Exposure duration (years)
<i>BW</i>	=	Body weight (kg)
<i>AT</i>	=	Averaging time (days)
		For non-carcinogens, AT = ED × 365 days/year
		For carcinogens, AT = 70 years × 365 days/year
<i>CF</i>	=	Conversion Factor (10 <sup>-6</sup> kilograms per milligram [kg/mg]).

For COPCs that are considered mutagenic (i.e., PAHs as discussed in Section 2.3.2), the generic equation to calculate ingestion intake is modified as identified below:

$$(L)ADI = \frac{EPC \times IFSMadj \times EF}{AT}$$

where:

<i>(L)ADI</i>	=	(Lifetime) Average daily intake (mg/kg-day)
<i>EPC</i>	=	Concentration of a COPC in soil (mg/kg)
<i>IFSMadj</i>	=	Mutagenic Ingestion Rate [(IR × ED × Mutagenic adjustment factor)/BW], (mg-yr/kg-day)
<i>EF</i>	=	Exposure frequency (days/year)
<i>AT</i>	=	Averaging time (days)
		For non-carcinogens, AT = ED x 365 days/year
		For carcinogens, AT = 70 years x 365 days/year

The generic equation to calculate dermal intake from soil is given below:

$$(L)ADI = \frac{EPC \times SA \times DA \times EF \times ED \times CF}{BW \times AT}$$

where

<i>(L)ADI</i>	=	(Lifetime) Average daily intake (mg/kg/day)
<i>EPC</i>	=	Concentration of a COPC in soil (mg/kg)
<i>SA</i>	=	Surface Area for Contact (cm <sup>2</sup> )
<i>DA</i>	=	Absorbed Dose For soil DA = Absorption Factor (ABS) × Adherence Factor (AF) (mg/cm <sup>2</sup> )
<i>EF</i>	=	Exposure frequency (days/year)
<i>ED</i>	=	Exposure duration (years)
<i>BW</i>	=	Body weight (kg)
<i>AT</i>	=	Averaging time (days) For non-carcinogens, AT = ED × 365 days/year For carcinogens, AT = 70 years × 365 days/year
<i>CF</i>	=	Conversion Factor (10 <sup>-6</sup> kg/mg).

For chemicals that are considered mutagenic (i.e., PAHs as described in Section 2.3.2), the generic equation to calculate dermal intake from soil is modified as identified below:

$$(L)ADI = \frac{EPC \times DFSMadj \times DA \times EF \times CF}{AT}$$

where

<i>(L)ADI</i>	=	(Lifetime) Average daily intake (mg/kg/day)
<i>EPC</i>	=	Concentration of a COPC in soil (mg/kg)
<i>DFSMadj</i>	=	Mutagenic Dermal Contact Factor For soil (mg-year/kg-day) = (SA × ED × AF × Mutagenic Adjustment Factor/BW)
<i>DA</i>	=	Absorbed Dose For soil DA = Absorption Factor (ABS) (unitless)
<i>EF</i>	=	Exposure frequency (days/year)
<i>ED</i>	=	Exposure duration (years)
<i>AT</i>	=	Averaging time (days)
<i>CF</i>	=	Conversion Factor (10 <sup>-6</sup> kg/mg).

The intake of particulates and vapors/gases were calculated using the same equation (EPA 2009a):

$$EC = \frac{C_{air} \times ET \times EF \times ED \times CF_1}{AT \times CF_2}$$

Where,

<i>EC</i>	=	Exposure concentration (milligrams per cubic meter [mg/m <sup>3</sup> ] or µg/m <sup>3</sup> )
<i>C<sub>air</sub></i>	=	Concentration of chemical in air (mg/m <sup>3</sup> )
<i>ET</i>	=	Exposure time (hours)
<i>EF</i>	=	Exposure frequency (days/year)
<i>ED</i>	=	Exposure duration (years)
<i>CF<sub>1</sub></i>	=	Conversion Factor (1,000 µg/mg) (carcinogenic intakes only)
<i>CF<sub>2</sub></i>	=	Conversion Factor (24 hours/day)
<i>AT</i>	=	Averaging time (days)
		For non-carcinogens, AT = ED x 365 days/yr
		For carcinogens, AT = 70 years x 365 days/yr

The concentration of chemicals in air resulting from emissions from soil is developed following procedures presented in the EPA Soil Screening guidance (EPA 2002c). The chemical concentration in air is calculated from:

$$C_{air} = C_{soil} \times \left[ \frac{1}{PEF} \right]$$

Where,

<i>C<sub>air</sub></i>	=	Concentration of chemical in air (mg/m <sup>3</sup> )
<i>C<sub>soil</sub></i>	=	Chemical concentration in soil (mg/kg)
<i>PEF</i>	=	Particulate emission factor (m <sup>3</sup> /kg)

The PEF relates the concentration of a chemical in soil with the concentration of dust particles in air. For residential exposures, a PEF value of 2.78x10<sup>9</sup> is used based on a 0.5 acre site and using EPA guidance values for Houston, TX (EPA 2002b). For a construction worker, the PEF is based upon potential construction that may occur at the Site. The PEF was calculated based upon excavation, grading, and tilling at the Site which results in a PEF from other than vehicle traffic (EPA 2013a).

### 2.2.5 Selection of Exposure Parameters

The second step in quantifying intake requires the identification of exposure parameters. Exposure parameters include rates of contact (e.g., ingestion rates, skin surface areas, etc.), exposure frequency (EF) and duration, body weight (BW), and averaging time. The contact rate reflects the amount of contaminated media contacted per unit time or event. EF and duration are used to estimate the total time of exposure to COPC in media of concern. The BW represents the average BW over an exposure period (EPA 1989). Specific exposure parameters for each receptor are chosen based on EPA guidance (EPA 1989, 1991a, 1991b, 1997a, 2004, 2011, and

2013a) and other appropriate resources. Exposure parameters for AOC-4 are presented in Tables 7 through 9.

### **Soil Exposure Assessment**

Exposure parameters for resident adult and child exposure to soil are presented on Tables 7 and 8, and exposure parameters for the construction worker are presented on Table 9. The ingestion rate for residential exposure to soil is presented in multiple EPA guidance documents and is assumed at 100 mg/kg for the adult and 200 mg/kg for the child (EPA 1991a, 1991b, 2011, and 2013a). The ingestion rate for the construction worker was taken from guidance for the calculation of the EPA RSLs and Supplemental Guidance for Developing Soil Screening Levels (EPA 2002b, 2013a). A construction worker soil ingestion rate of 330 mg/kg is assumed. Dermal exposure to soil is assumed for exposed body surface areas only. The surface area (SA) available for contact is presented in the EPA RAGS E guidance and generally assumes hands, forearms, head, and feet for the resident. The recommended SA for the adult is 5,700 cm<sup>2</sup> and the child is 2,800 cm<sup>2</sup>, based on the mean SA (EPA 2004). The construction worker/site worker is only assumed to contact soil with hands, forearms, and head with a mean SA of 3,300 cm<sup>2</sup> (EPA 2004). The inhalation of soil particulates assumes a 24 hour exposure period for the resident and an 8 hour work day for the construction worker. The resident adult and construction worker were assumed to weigh 70 kg, and the resident child was assumed to weigh 15 kg. The resident adult is expected to be exposed to soil for a 24-year duration at a frequency of 350 days per year. The resident child was expected to be exposed to soil for 6 years at a frequency of 350 days per year. The construction worker was assumed to contact soil for 250 days per year over a one year construction period.

## **2.3 TOXICITY ASSESSMENT**

Toxicity assessment is the third step of the HHRA process. The toxicity assessment considers the types of potential adverse health effects associated with exposures to COPC, the relationship between the magnitude of exposure and potential adverse effects, and related uncertainties, such as the weight of evidence of a particular COPC carcinogenicity in humans. EPA guidance (EPA 1989) specifies that the assessment be accomplished in two steps: hazard identification and dose-response assessment. Hazard identification is the process of determining whether studies demonstrate that exposure to a COPC may cause the incidence of an adverse effect. EPA specifies the dose-response assessment, which involves: (1) EPA's quantitative evaluation of the existing toxicity information, and (2) EPA's characterization of the relationship between the dose of the COPC administered or received, and the incidence of potentially adverse health effects in the exposed population. From this quantitative dose-response relationship, specific toxicity values are derived by EPA that can be used to estimate the incidence of potentially adverse effects occurring in humans at different exposure levels (EPA 1989).

Toxicity values were selected in keeping with appropriate exposure durations and EPA guidance (EPA 2003). Tier 1 values were found using the Integrated Risk Information System (IRIS) (EPA 2014a) for established, current values. When toxicity values were not available from IRIS, Tier 2 values were then examined.

Tier 2 values were EPA's Provisional Peer Reviewed Toxicity Values, which are developed by the Office of Research and Development, the National Center for Environmental Assessment, and the Superfund Health Risk Technical Support Center on a chemical-specific basis when requested by the Superfund program.

Tier 3, other toxicity values, were considered when Tier 1 or Tier 2 toxicity values were not available. These toxicity values were taken from additional EPA and non-EPA sources and were chosen based on the most current and best peer-reviewed source available. The California EPA Office of Environmental Health Hazard Assessment Toxicity Criteria Database (California Environmental Protection Agency 2014), California EPA Cancer Potency Values (California Environmental Protection Agency 2009), and the Health Effects Assessment Summary Tables (EPA 1997b) are the Tier 3 sources utilized for this HHRA.

### **2.3.1 Toxicity Assessment for Non-Carcinogens**

The methodology used by EPA for deriving non-cancer reference values for non-carcinogens, and site-specific considerations for modifying or using these concentrations are discussed in detail in Barnes and Dourson (1988) and EPA guidance (EPA 2014a). Non-carcinogens are typically judged to have a threshold daily dose below which deleterious or harmful effects are unlikely to occur. This concentration is called the no-observed-adverse-effect-level (NOAEL), and may be derived from either animal laboratory experiments or human epidemiology investigations (usually workplace studies). In developing a toxicity value or human NOAEL for non-carcinogens (i.e., a reference dose [RfD]), the regulatory approach is to (1) identify the critical toxic effect associated with chemical exposure (i.e., the most sensitive adverse effect); (2) identify the threshold dose in either an animal or human study; and (3) modify this dose to account for interspecies variability (where appropriate), differences in individual sensitivity (within-species variability), and other uncertainty and modifying factors. For the Reference Concentrations (RfCs), experimental exposures are extrapolated to a Human Equivalent Concentration (HEC). The HEC is determined through a two-step process that begins with a point of departure, which is adjusted (multiplied) by a Dosimetric Adjustment Factor (DAF) (EPA 2009a). The point of departure can represent a NOAEL, lowest-observed-adverse-effect-level (LOAEL), benchmark concentration, lower confidence limit, and the lower limit on an effective concentration using a 10 percent response level ( $LEC_{10}$ ). The DAF is for the specific site of the chemical's effects (e.g., respiratory tract, etc.). The DAF is dependent upon the nature of the contaminant and the target site of the toxic effect.

Uncertainty factors (UFs) are intended to account for specific types of uncertainty inherent in extrapolation from the available data. The UFs are generally 10-fold, default factors used in operationally deriving the RfD and RfC from experimental data. UFs less than 10 can be used. A UF of 3 can be used in place of one-half power ( $10^{0.5}$ ) when appropriate. The UFs are intended to account for (1) variation in susceptibility among the members of the human population (i.e., inter-individual or intraspecies variability), (2) uncertainty in extrapolating animal data to humans (i.e., interspecies uncertainty), (3) uncertainty in extrapolating from data obtained in a study with less-than-lifetime exposure (i.e., extrapolating from subchronic to

chronic exposure), (4) uncertainty in extrapolating from a LOAEL rather than from an NOAEL, and (5) uncertainty associated with extrapolation when the database is incomplete. The maximum UF for the derivation of the RfCs used in this HHRA is 1,000. The maximum UF for the derivation of the RfDs used in this HHRA is 3,000. To calculate the RfD, the appropriate NOAEL is divided by the product of all the applicable UFs. This is expressed as:

$$\text{RfD} = \text{NOAEL} / (\text{UF}_1 \times \text{UF}_2 \times \text{UF}_3 \times \text{UF}_4)$$

The resulting RfD is expressed in units of milligrams of chemical per kilogram of body weight per day (mg/kg-BW/day). To calculate the RfC, the HEC is divided by UFs and is expressed in units of milligrams per cubic meter (mg/m<sup>3</sup>). EPA-derived toxicity values for evaluating potential chronic non-carcinogenic effects for COPCs are summarized in Tables 10 and 11.

### 2.3.2 Toxicity Assessment for Carcinogenicity

Unlike non-carcinogens, carcinogens are generally assumed to have no threshold. There is presumed to be no level of exposure below which carcinogenic effects will not manifest themselves. This “non-threshold” concept supports the idea that there are small, finite probabilities of inducing a carcinogenic response associated with every level of exposure to a potential carcinogen. EPA uses a two-part evaluation for carcinogenic effects. This evaluation includes the assignment of a weight-of-evidence classification and the quantification of a cancer toxic potency concentration. Quantification is expressed as a slope factor (SF) for oral and dermal exposures and an Inhalation Unit Risk (IUR) for inhalation exposures, which reflects the dose-response data for the carcinogenic endpoint(s) (EPA 1989, 2009a). EPA-derived toxicity values for evaluating potential carcinogenic effects for COPCs are summarized in Tables 13 and 14.

The weight-of-evidence classification system assigns a letter or alphanumeric (A through E) to each potential carcinogen that reflects an assessment of its potential to be a human carcinogen (EPA 1986).<sup>1</sup> The EPA has established six recommended standard hazard descriptors: “*Carcinogenic to Humans*,” “*Likely to Be Carcinogenic to Humans*,” “*Suggestive Evidence of Carcinogenic Potential*,” “*Inadequate Information to Assess Carcinogenic Potential*,” and “*Not Likely to Be Carcinogenic to Humans*” (EPA 2005a). The weight-of-evidence classification is based on a thorough scientific examination of the body of available data. Only compounds that have a weight-of-evidence classification of C or above are considered to have carcinogenic potential in this HHRA.

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<sup>1</sup>A = A known human carcinogen; B1 = A probable human carcinogen, based on sufficient animal data and limited human data; B2 = A probable human carcinogen based on sufficient animal data and inadequate or no human data; C = A possible human carcinogen; D = Not classifiable as to human carcinogenicity; and E = Evidence of non-carcinogenicity for humans.

The SF and the IUR are the upper 95<sup>th</sup> percentile confidence limit of the probability of response per unit daily intake of a chemical over a lifetime. The SF is expressed in units of proportion (of a population) affected per milligrams per kilograms per day (mg/kg/day). The IUR is expressed in micrograms per cubic meter ( $\mu\text{g}/\text{m}^3$ ). Typically, the SF and the IUR are used to estimate the upper-bound lifetime probability of a person developing cancer from exposure to a given concentration of a carcinogen. SFs and IURs are generally based on experimental animal data, unless suitable epidemiological studies are available. Because of the difficulty in detecting and measuring carcinogenic endpoints at low exposure concentrations, SFs and IURs are typically developed by using a model to fit the available high dose, experimental animal data, and then extrapolating downward to the low-dose range to which humans are typically exposed. EPA recommends the linear multistage model to derive an SF and IUR. The model is conservative and provides an upper bound estimate of excess lifetime cancer risk. These methods and approaches are discussed in greater detail within the EPA *Cancer Guidelines* (EPA 2005a).

Carcinogenic compounds were also assessed for mutagenic modes of action. The mutagenic mode of action is assessed with a linear approach (EPA 2005b). Benz(a)anthracene, benzo(b)fluoranthene, benzo(a)pyrene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene are the COPC that have been identified with a mutagenic mode of action. COPCs identified as mutagenic have sensitivity pertaining to cancer risks associated with early-life exposures. To account for the early-life exposure and the mutagenic mode of action, the cancer potency estimates are adjusted by an age-dependent adjustment factor (ADAF). The EPA recommends, for mutagenic chemicals, when no chemical-specific data exist, a default approach using estimates from chronic studies (i.e., cancer slope factors) with appropriate modifications to address the potential for differential risk of early life stage exposure (EPA 2005a,b). An ADAF modification for early life stage exposure to mutagenic COPC is required because available studies indicate higher cancer risks resulting from a given exposure occurring early in life when compared with the same amount of exposure during adulthood (EPA 2005b). For this HHRA, the intakes for COPC identified with a mutagenic mode of action are modified by an ADAF for the following (EPA 2005b, 2014a):

- For exposures before 2 years of age (i.e., spanning a 2-year time interval from the first day of birth up until a child's second birthday), a 10-fold adjustment.
- For exposures between 2 and <16 years of age (i.e., spanning a 14-year time interval from a child's second birthday up until their sixteenth birthday), a 3-fold adjustment.
- For exposures after turning 16 years of age, no adjustment.

For this HHRA, the resident is within the age range that requires adjustment for a mutagenic mode of action. Two age groups are considered for the residential scenario, an adult and a child. The age group for the child is assumed at 0-6 years. The resident adult is evaluated from an age range of 7-30 years old (EPA 1991b). Although adults are typically assumed at an age range of greater than 16 years of age, the resident adult is evaluated for a long-term exposure typical of residents (EPA 1991b). Residents are typically assumed at a duration of 30 years, so the resident

adult spans that 7-30 years beyond childhood (EPA 1991a). Therefore, both the resident child and the resident adult require an adjustment for potential mutagenic modes of action.

### **2.3.3 Toxicity Assessment Modification for Dermal Contact**

Toxicity values specific to dermal exposures are not available and require adjustment of the oral toxicity values (oral RfDs or SFs). This adjustment accounts for the difference between the daily intake dose through dermal contact as opposed to ingestion. Most toxicity values are based on the actual administered dose and must be corrected for the percent of chemical-specific absorption that occurs across the gastrointestinal tract prior to use in dermal contact risk assessment (EPA 1989, 2004). EPA recommends utilizing oral absorption efficiency factors in converting oral toxicity values to dermal toxicity values (EPA 2004). This adjustment accounts for the absorption efficiency in the “critical study,” which is utilized in determining the RfD and SF. Where oral absorption in the critical study is essentially complete (i.e., 100 percent), the absorbed dose is equivalent to the administered dose, and no adjustment of oral toxicity values is necessary when evaluating dermal exposures. When gastrointestinal absorption of a chemical in the critical study is poor (e.g., 1 percent), the absorbed dose is much smaller than the administered dose, and toxicity values for dermal exposure are adjusted to account for the difference in the absorbed dose relative to the administered dose. To account for the differences between the administered (oral) and the absorbed (dermal) dose, RfDs and SFs are modified by the gastrointestinal dermal absorption factor (GIABS). Table 12 presents the chemical-specific parameters for dermal contact.

In addition to the GIABS modification of the toxicity values for dermal contact, dermal contact rates are also evaluated based upon a chemical’s ability to be absorbed through the skin surface. For soil, the EPA has identified a dermal absorption factor (ABS) that is chemical-specific. The ABS value reflects the desorption of a chemical from soil and the absorption of the chemical across the skin and into the blood stream. Recommended values are presented that take into account ranges of values that result from different soil types, loading rates, chemical concentrations, and other conditions.

## **2.4 RISK CHARACTERIZATION**

Risk characterization is the fourth step of the HHRA process. In this step, the toxicity values are combined with the calculated chemical intakes for the receptor populations to quantitatively estimate both carcinogenic and non-carcinogenic risks. Risks were calculated for each receptor of concern.

### **2.4.1 Hazard Index for Non-Carcinogenic Effects**

The potential human health risks associated with exposures to non-carcinogenic COPC are calculated by comparing the ADI or the EC with the chemical-specific RfD or RfC, as per EPA Guidance (EPA 1989, 2009a). A hazard quotient (HQ) is derived for each COPC, as shown in the equation below:

$$HQ = \frac{ADI}{RfD} \quad \text{or} \quad HQ = \frac{EC}{RfC}$$

where

<i>HQ</i>	=	Hazard Quotient; ratio of average daily intake level to acceptable daily intake level (unitless)
<i>ADI</i>	=	Calculated non-carcinogenic average daily intake (mg/kg/day or mg/m <sup>3</sup> )
<i>EC</i>	=	Exposure Concentration (mg/m <sup>3</sup> )
<i>RfD</i>	=	Reference dose (mg/kg/day)
<i>RfC</i>	=	Reference concentration (mg/m <sup>3</sup> ).

If the average daily dose exceeds the RfD or RfC, the HQ will exceed a ratio of one (1.0) and there may be concern that potential adverse systemic health effects will be observed in the exposed populations. If the ADI does not exceed the RfD or the RfC, the HQ will not exceed 1.0 and there will be no concern that potential adverse systemic health effects will be observed in the exposed populations. However, if the sum of several HQs exceeds 1.0, and the COPC affect the same target organ, there may be concern that potential adverse systemic health effects will be observed in the exposed populations. In general, the greater the value of the HQ above 1.0, the greater the level of concern. However, the HQ does not represent a statistical probability that an adverse health effect will occur.

For consideration of exposures to more than one chemical causing systemic toxicity via several different pathways, the individual HQs are summed to provide an overall hazard index (HI). If the HI is less than 1.0, then no adverse health effects are likely to be associated with exposures at the Site. However, if the total HI is greater than 1.0, separate endpoint-specific HIs may be calculated based on toxic endpoint of concern or target organ (e.g., HQs for neurotoxins are summed separately from HQs for renal toxins). Only if an endpoint-specific HI is greater than 1.0 is there reason for concern about potential health effects for that endpoint.

#### 2.4.2 Carcinogenic Risks

Carcinogenic risk is calculated as the incremental probability of an individual developing cancer over a lifetime as a result of exposure to a potential carcinogen. The numerical estimate of excess lifetime cancer risk is calculated by multiplying the LADI by the risk per unit dose (the SF) or multiplying the EC by the IUR.

This is shown in the following equation:

$$\begin{aligned} \text{Risk} &= \text{LADI} \times \text{SF} \\ \text{Risk} &= \text{EC} \times \text{IUR} \end{aligned}$$

where

<i>Risk</i>	=	Unitless probability of an exposed individual developing cancer
<i>LADI</i>	=	Lifetime cancer average daily intake (mg/kg/day)
<i>EC</i>	=	Exposure Concentration ( $\mu\text{g}/\text{m}^3$ )
<i>SF</i>	=	Cancer slope factor ( $\text{mg}/\text{kg}/\text{day})^{-1}$
<i>IUR</i>	=	Inhalation Unit Risk ( $\mu\text{g}/\text{m}^3$ ) <sup>-1</sup> .

Because the SF and the IUR are the statistical 95<sup>th</sup> percent upper-bound confidence limit on the dose-response slope, this method provides a conservative, upper-bound estimate of risk. It should be noted that the interpretation of the significance of the cancer risk estimate is based on the appropriate public policy. EPA in the NCP (40 Code of Federal Regulation Part 300) (EPA 1990) states that:

*...For known or suspected carcinogens, acceptable exposure levels are generally concentration levels that represent an excess upper bound lifetime cancer risk to an individual of between  $10^{-4}$  and  $10^{-6}$ .*

### 2.4.3 Risk Characterization Results

The methodologies used to quantify carcinogenic risks and chronic hazards for non-carcinogens are described further in Section 2.2. Calculations are presented by receptor in Tables 15 through 20. Tables 21 and 22 present the estimation of COPC air concentrations of particulate from soil for the resident and construction worker, respectively. The determination of the PEF for the construction worker was performed using the EPA Regional Screening Table Calculator (EPA 2014c). Outputs from the calculator for the PEF are provided in Appendix D.

Estimates of cumulative risks across all pathways for non-carcinogenic and carcinogenic effects for all receptors are presented in Tables 23 through 26. If cumulative non-carcinogenic hazards are greater than 1.0, a breakdown by target organ is provided.

#### 2.4.3.1 Surface Soil

##### Resident Adult and Child

Calculations for the resident adult and child are presented in Tables 15 and 16. Estimates of cumulative risks across all pathways for non-carcinogenic and carcinogenic effects are presented in Table 23. The total non-carcinogenic HI for the resident adult is 0.1, which is below the acceptable threshold of 1.0 (Table 23). The total non-carcinogenic HI for the resident child is 1, which is equal the acceptable threshold of 1.0 (Table 23). No COPC has a chemical-specific HQ greater than 1. A breakdown by target organ is provided for the resident child on Table 23. No target organ has an HI greater than 1.

Carcinogenic risks for the resident adult and child are combined to account for an excess, lifetime cumulative carcinogenic risk. The cumulative lifetime carcinogenic risk for the resident

adult and child combined is  $5 \times 10^{-5}$  (Table 23), which is within the EPA's target risk range of  $10^{-4}$  to  $10^{-6}$ . Benzo(a)pyrene is the only COPC with carcinogenic risks greater than  $10^{-5}$ . Arsenic, benz(a)anthracene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-c,d)pyrene have carcinogenic risks greater than  $10^{-6}$ .

### **Construction Worker**

Calculations for the construction worker are presented in Table 17. Estimates of cumulative risks across all pathways for non-carcinogenic and carcinogenic effects are presented in Table 24. The total non-carcinogenic HI for the construction worker is 0.3, which is below the acceptable threshold of 1.0 (Table 24).

The carcinogenic risk for the construction worker is  $6 \times 10^{-7}$  (Table 24), which is within the EPA's target risk range of  $10^{-4}$  to  $10^{-6}$ .

#### **2.4.3.2 Subsurface Soil**

### **Resident Adult and Child**

Calculations for the resident adult and child are presented in Tables 18 and 19. Estimates of cumulative risks across all pathways for non-carcinogenic and carcinogenic effects are presented in Table 25. The total non-carcinogenic HI for the resident adult is 0.04, which is below the acceptable threshold of 1.0 (Table 265). The total non-carcinogenic HI for the resident child is 0.3, which is below the acceptable threshold of 1.0 (Table 25).

Carcinogenic risks for the resident adult and child are combined to account for an excess, lifetime cumulative carcinogenic risk. The cumulative lifetime carcinogenic risk for the resident adult and child combined is  $2 \times 10^{-5}$  (Table 25), which is within the EPA's target risk range of  $10^{-4}$  to  $10^{-6}$ . Benzo(a)pyrene is the only COPC with carcinogenic risks greater than  $10^{-5}$ . Arsenic, benz(a)anthracene, and benzo(b)fluoranthene have carcinogenic risks greater than  $10^{-6}$ .

### **Construction Worker**

Calculations for the construction worker are presented in Table 20. Estimates of cumulative risks across all pathways for non-carcinogenic and carcinogenic effects are presented in Table 26. The total non-carcinogenic HI for the construction worker is 0.08, which is below the acceptable threshold of 1.0 (Table 26).

The carcinogenic risk for the construction worker is  $2 \times 10^{-7}$  (Table 26), which is within the EPA's target risk range of  $10^{-4}$  to  $10^{-6}$ .

#### **2.4.3.3 Ground Water**

Both arsenic and manganese are considered COPCs for both the total and dissolved fractions. The concentration of both analytes is similar for both fractions, which reveals that arsenic and

manganese are present primarily in the dissolved phase in ground water. The maximum detected concentration of dissolved arsenic (60.8 µg/L) exceeds both the arsenic tap water RSL (0.045 µg/L) and the MCL (10 µg/L). The maximum detected arsenic concentration is approximately three orders of magnitude higher than the tap water RSL, which would result in carcinogenic risk levels above the EPA acceptable risk range. The maximum detected concentration of dissolved manganese (133 µg/L) exceeds modified (i.e., by 1/10<sup>th</sup>) the tap water RSL (32.0 µg/L). However, the maximum concentration does not exceed the full tap water RSL of 320 µg/L. This reveals that the concentration of manganese would be below the acceptable non-carcinogenic hazard of 1.

## **2.5 AOC-4 CONCLUSIONS**

The AOC-4 HHRA evaluated potential cumulative risks for the resident adult and child and construction worker exposure to surface soil and subsurface soil. Evaluation of non-carcinogenic hazards did not exceed 1.0 for any of the receptors. Carcinogenic risks for all receptors evaluated are within or below the U.S. EPA's "acceptable risk range." For surface soil, arsenic, benz(a)anthracene, benzo(b)fluoranthene, benzo(a)pyrene, dibenz(a,h)anthracene, and indeno(1,2,3-c,d)pyrene have carcinogenic risks greater than 10<sup>-6</sup>. All of these COPCs were detected in each of the six surface soil samples. For subsurface soil, arsenic, benz(a)anthracene, benzo(b)fluoranthene, and benzo(a)pyrene have carcinogenic risks greater than 10<sup>-6</sup>.

Ground water was evaluated qualitatively because only one sample result is available. The maximum detected concentration of dissolved arsenic (60.8 µg/L) exceeds both the arsenic tap water RSL (0.045 µg/L) and the MCL (10 µg/L). The maximum detected arsenic concentration is approximately three orders of magnitude higher than the tap water RSL, which would result in carcinogenic risk levels above the EPA acceptable risk range.

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### **3. RISK ASSESSMENT UNCERTAINTY**

There are numerous uncertainties involved in the HHRA process. These are discussed briefly in the following sections.

#### **3.1 SAMPLING AND ANALYSIS UNCERTAINTIES**

The sampling plan can have a significant impact on the results obtained in calculating human health risks at a site. Surface soil, subsurface soil, and ground water background samples were collected for the Site. The location of these samples is provided on Figure 4, and the sample results are provided in Appendix B. The background UPLs for surface soil, subsurface soil, and ground water are provided on Tables 1 through 3, respectively. Chemicals were not removed from consideration in the HHRA based upon a comparison to background concentrations. All chemicals with maximum detected concentrations above the applicable RSL were considered quantitatively in the HHRA. However, a qualitative discussion of AOC-4 soil and ground water concentrations to background concentrations is provided.

The maximum detected concentration of aluminum, arsenic, cobalt, and mercury exceeded the background UPLs in surface soil. Iron and manganese maximum detected concentrations were less than the background UPLs. No PAHs were detected in the background samples. In surface soil, arsenic and PAHs (benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-c,d)pyrene) were the COPCs that contributed to the carcinogenic risk results. In subsurface soil, the maximum detected concentration of all COPCs (i.e., arsenic, mercury, benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-c,d)pyrene ) was above the background UPLs.

For ground water, the detected concentrations of total and dissolved arsenic were above the background UPLs. The detected concentrations of total and dissolved manganese were below the background UPLs. The detected concentrations of arsenic in ground water exceeds both the tap water RSL of 0.045 µg/L and the MCL of 10 µg/L.

#### **3.2 UNCERTAINTIES ANALYSIS OF EXPOSURE ASSESSMENT**

An analysis of uncertainties is an important aspect of the exposure assessment. It provides the risk assessor and reviewer with information relevant to the individual uncertainties associated with exposure factor assumptions and their potential impact on the final assessment. Exposure is evaluated only within the AOC boundaries. The delineation of the AOC boundaries allows for a determination of potential human health concerns for the AOC itself but does not necessarily represent actual exposure that would occur. The size of AOC-4 is representative of a residential yard, which limits the uncertainty associated with this area.

##### **3.2.1 Dermal Exposures**

Dermal contact rates for COPC in soil are evaluated based upon a chemical's ability to be absorbed through the skin surface. The EPA has identified a dermal ABS that reflects the

desorption of a chemical from soil and the absorption of the chemical across the skin and into the blood stream. ABS values are not available for most inorganics in EPA RAGS E guidance (EPA 2004). Dermal contact with skin is expected to be a significant exposure, especially for children. However, inorganics are often not well-absorbed through the skin. It is difficult to estimate the effects of generic ABS values on risk results. The absorption of inorganics is primarily a concern if skin is occluded (EPA 1995). However, non-occluded skin is not expected to have absorption. Therefore, risks determined for the dermal contact exposure pathway are most likely overestimated.

### **3.3 UNCERTAINTIES OF TOXICITY ASSESSMENT**

There are numerous uncertainties associated with the toxicity assessment. These are generally due to the unavailability of data to thoroughly calculate the toxicity of COPC. These uncertainties are described in more detail in the following sections.

#### **3.3.1 Uncertainties Associated with Non-Carcinogenic Effects**

##### **4.3.1.1 Interspecies Extrapolation**

The majority of toxicological information comes from experiments with laboratory animals. Experimental animal data have been relied on by regulatory agencies to assess the hazards of chemical exposures to humans. Interspecies differences in chemical absorption, metabolism, excretion, and toxic response are not well understood; therefore, conservative assumptions are applied to animal data when extrapolating to humans. These probably result in an overestimation of toxicity.

##### **4.3.1.2 Intraspecies Extrapolation**

Differences in individual human susceptibilities to the effects of chemical exposures may be caused by such variables as genetic factors (e.g., glucose-6-phosphate dehydrogenase deficiency), lifestyle (e.g., cigarette smoking and alcohol consumption), age, hormonal status (e.g., pregnancy), and disease. To take into account the diversity of human populations and their differing susceptibilities to chemically induced injury or disease, a safety factor is used. EPA uses a factor between 1 and 10. This uncertainty may lead to overestimates of human health effects at given doses.

#### **3.3.2 Exposure Routes**

When experimental data available on one route of administration are different from the actual route of exposure that is of interest, route-to-route extrapolation must be performed before the risk can be assessed. Several criteria must be satisfied before route-to-route extrapolation can be undertaken. The most critical assumption is that a chemical injures the same organ(s) regardless of route, even though the injury can vary in degree. Another assumption is that the behavior of a substance in the body is similar by all routes of contact. This may not be the case when, for example, materials absorbed via the gastrointestinal tract pass through the liver prior to reaching

the systemic circulation, whereas by inhalation the same chemical will reach other organs before the liver. However, when data are limited, these extrapolations are made and may result in overestimates of human toxicity.

### **3.3.3 Uncertainties Associated with Carcinogenic Effects**

#### **4.3.3.1 Interspecies Extrapolation**

The majority of toxicological information for carcinogenic assessments comes from experiments with laboratory animals. There is uncertainty about whether animal carcinogens are also carcinogenic in humans. While many chemical substances are carcinogenic in one or more animal species, only a very small number of chemical substances are known to be human carcinogens. The fact that some chemicals are carcinogenic in some animal species, but not in others, raises the possibility that not all animal carcinogens are human carcinogens. Regulatory agencies assume that humans are as sensitive to carcinogens as the most sensitive animal species. This policy decision, designed to prevent underestimation of risk, introduces the potential to overestimate carcinogenic risk.

#### **4.3.3.2 High-Dose to Low-Dose Extrapolation**

Typical cancer bioassays provide limited low-dose data on responses in experimental animals for chemicals being assessed for carcinogenic or chronic effects. The usual dose regime involves three dose groups per assay. The first dose group is given the highest dose that can be tolerated, the second is exposed to one-half that dose, and the third group is unexposed (control group) (National Research Council 1983). Because this dosing method does not reflect how animals would react to much lower doses of a chemical, a dose-response assessment normally requires extrapolation from high to low doses using mathematical modeling that incorporates to varying degrees information about physiologic processes in the body (National Research Council 1983).

A central problem with the low-dose extrapolation models is that they often fit the data from animal bioassays equally well, and it is not possible to determine their validity based on goodness of fit. Several models may fit experimental data equally well, but all may not be equally plausible biologically. The dose-response curves derived from different models diverge substantially in the dose range of interest (National Research Council 1983). Therefore, low-dose extrapolation is more than a curve-fitting process, and considerations of biological plausibility of the models must be taken into account before choosing the best model for a particular set of data.

### **3.3.4 Modification for Mutagenic Compounds**

Carcinogenic slope factors for compounds identified with a mutagenic mode of action for early-life exposure are modified by a default adjustment factor. The default adjustment factors are used because chemical-specific data are not available to directly assess cancer susceptibility from early-life exposure to a carcinogen acting through a mutagenic mode of action. The default adjustment factors are derived from a weighted geometric mean tumor incidence ratio.

Therefore, the use of the default adjustment factors may both over-estimate and under-estimate the potential potency for early-life exposure for chemicals with a mutagenic mode of action for carcinogenesis (EPA 2005b). However, the analysis of potential exposure over a lifetime reduces the effects and uncertainty of the mutagenic adjustments on estimated lifetime cancer risk. Carcinogenic risks for receptors identified within the early-life exposure age range are determined based upon a lifetime exposure. The resulting uncertainty in the use of the mutagenic default adjustment factors is reduced but some uncertainty still remains in the use of default factors over a specified age range rather than chemical-specific data.

#### 4. CONCLUSIONS

The HHRA estimated the risk and hazard to potential human receptors for exposure to media within AOC-4 (Barge Dock) of the former Falcon Refinery Superfund Site. The Site is an inactive refinery located 1.7 miles southeast of State Highway 361 on FM 2725 at the north and south corners of FM 2725 and Bishop Road. The Site occupies approximately 104 acres in Ingleside, San Patricio County, Texas. The Site is divided into the North Site, South Site, and current barge dock facility. There are pipelines that connect the North and South Sites with the current and former barge dock facilities. The North Site consisted of nine ASTs, three truck loading racks, associated piping and a transfer pump. The South Site consisted of the main operations of the refinery. This area had a control room, heaters, crude towers, coalescers, boilers, fire water tank, exchangers, cooling towers, desalters, exchangers, compressors, a lab, 24 ASTs, separator, clarifiers, and aeration pond (TRC 2013). The barge dock facility, AOC-4, is located on Redfish Bay and was used to load and unload crude oil and refined hydrocarbons via pipelines that connect the dock to the North and South Sites.

The Site is located in the San Antonio-Nueces Coastal Basin adjacent to Redfish Bay, which connects Corpus Christi Bay to the Gulf of Mexico. Surface water drainage from the Site enters the wetlands along the southeastern section of the abandoned refinery. A culvert connects the onsite palustrine/estuarine wetlands to estuarine wetlands. The wetlands then connect to the Intracoastal Waterway and Redfish Bay. Ground Water at the Site is located approximately two feet below the ground's surface. Based upon ground water classifications set forth by the TCEQ, ground water below AOC-4 is a Class 2 ground water. Six ground water wells located within 1 mile of AOC-4 (TDLR 2014). One well is used as a domestic water supply, four wells are used as industrial water supplies for Gulf Marine Fabricators, and one well is used as an irrigation well. Public water supply is provided by the SPMWD, which supplies water to municipal water systems. The closest municipal water system to AOC-4 is the Ingleside Water Department. The SPMWD obtains its water supply from surface water sources.

The likely future land use for AOC-4 is to remain industrial. AOC-4 is located outside the Ingleside city limits and is not covered under zoning ordinances. The current owner of the property, Lazarus, is operating the entire Site, including AOC-4, as a crude oil bulk storage and transfer facility (TRC 2013). However, there are no known deed restrictions against future uses for AOC-4. As a result, receptors identified for AOC-4 include the resident adult, resident child, and construction worker. Site workers (i.e., landscapers/maintenance workers) and trespassers may also contact AOC-4. However, these receptors are expected to have relatively low contact with the area. The residential and construction worker exposure scenario represents conservative exposure scenarios that would account for all other expected receptor contact with the Site. Media of concern for AOC-4 include surface soil, subsurface soil, and ground water. Only one ground water sample was collected within AOC-4. As a result, ground water was evaluated qualitatively. Specific exposure pathways evaluated in the AOC-4 HHRA are presented in Figure 4.

The following table presents a summary of the HHRA results.

### Human Health Risk Assessment Summary of Results

Receptor	Media	Carcinogenic Risks <sup>1</sup>	Non-Carcinogenic Hazards	COPC Contributing Significantly to Results
<b>AOC-4</b>				
Surface Soil				
Child Resident <sup>1</sup>	Surface Soil	$5 \times 10^{-5}$	1	Not Applicable
Adult Resident <sup>1</sup>	Surface Soil	$5 \times 10^{-5}$	0.1	Not Applicable
Construction Worker	Surface soil	$6 \times 10^{-7}$	0.3	Not Applicable
Subsurface Soil				
Child Resident <sup>1</sup>	Subsurface Soil	$2 \times 10^{-5}$	0.3	Not Applicable
Adult Resident <sup>1</sup>	Subsurface Soil	$2 \times 10^{-5}$	0.04	Not Applicable
Construction Worker	Subsurface soil	$2 \times 10^{-7}$	0.08	Not Applicable
1 Cancer risk for the resident adult and child are combined and presented as a total lifetime cumulative cancer risk.				

The evaluation of non-carcinogenic hazards did not exceed 1.0 for any of the receptors. Carcinogenic risks for all receptors evaluated are within or below the U.S. EPA's "acceptable risk range." For surface soil, arsenic, benz(a)anthracene, benzo(b)fluoranthene, benzo(a)pyrene, dibenz(a,h)anthracene, and indeno(1,2,3-c,d)pyrene have carcinogenic risks greater than  $10^{-6}$ . All of these COPCs were detected in each of the six surface soil samples. For subsurface soil, arsenic, benz(a)anthracene, benzo(b)fluoranthene, and benzo(a)pyrene have carcinogenic risks greater than  $10^{-6}$ . A comparison to background UPLs revealed that all of these COPCs are above background concentrations.

Ground water was evaluated qualitatively because only one sample result is available for AOC-4. The maximum detected concentration of dissolved arsenic (60.8 µg/L) exceeds both the arsenic tap water RSL (0.045 µg/L) and the MCL (10 µg/L). The maximum detected arsenic concentration is approximately three orders of magnitude higher than the tap water RSL, which would result in carcinogenic risk levels above the EPA acceptable risk range. Additionally, the concentration of total and dissolved arsenic were above the background UPLs. However, one sample result is not representative of typical long-term exposure to ground water as a tap water source.

In conclusion, the HHRA did not reveal potential concerns for human health exposure at AOC-4.

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## **FIGURES**

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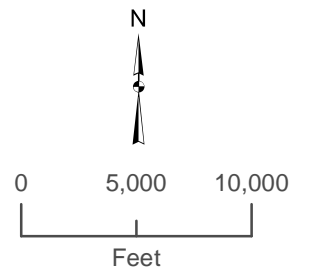


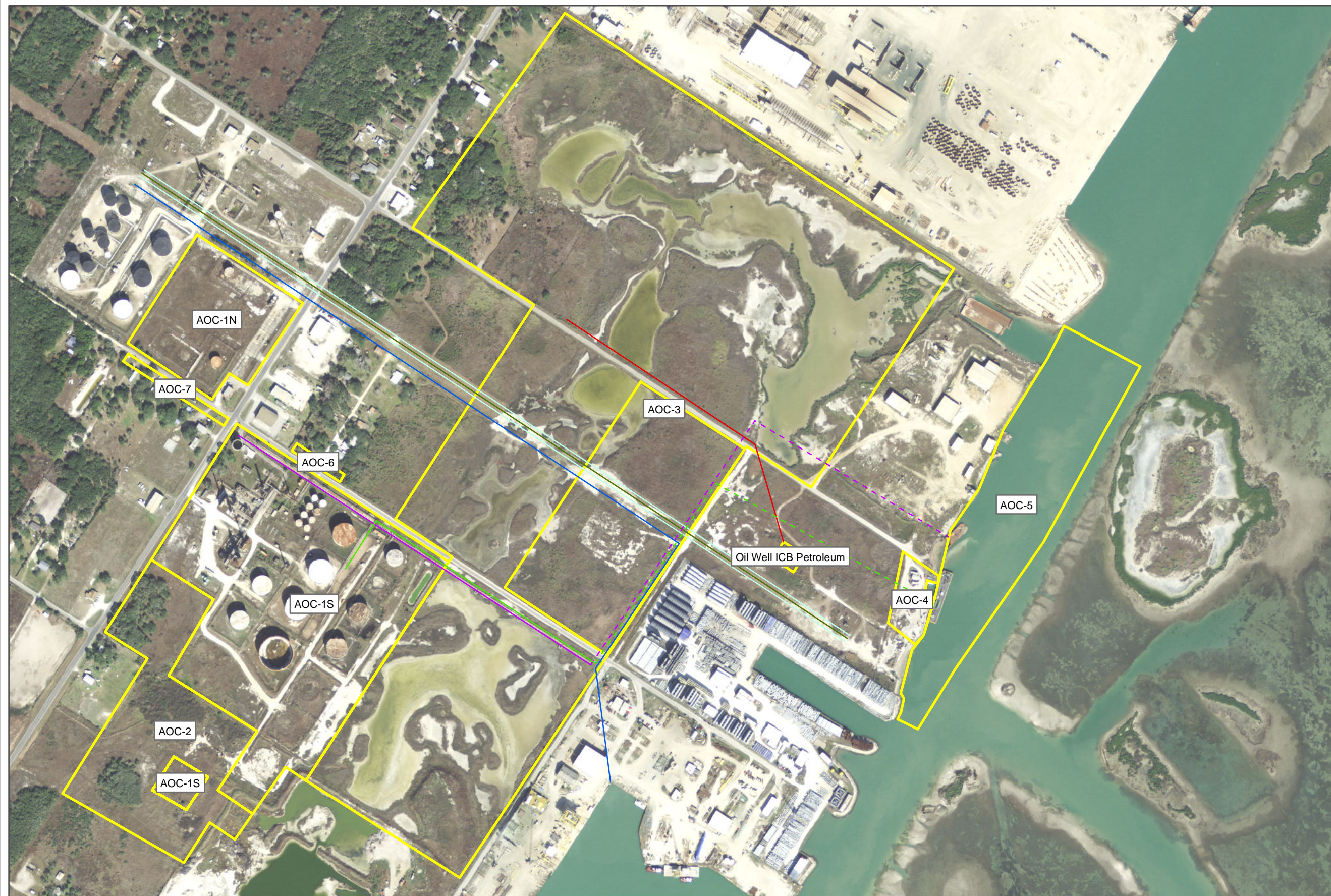
Image Source:  
ESRI ArcGIS Online USA Topo Maps layer,  
1:100,000 scale, Copyright:© 2011 National  
Geographic Society, i-cubed


Copyright:© 2013 National Geographic Society, i-cubed












Falcon Refinery Superfund Site  
Ingleside, San Patricio County, Texas

**Figure 1**  
**Location Map**  
Human Health Risk Assessment for AOC-4



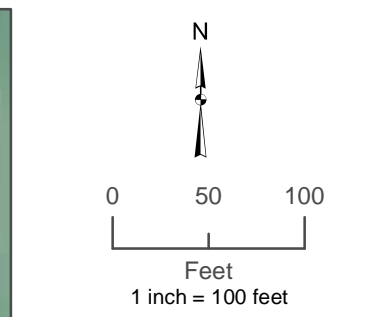
  
 0 250 500  
 Feet




**Legend:**

-  Area of Concern Boundary
- Active NORCO Pipeline**
  -  Above ground
  -  Underground
- Abandoned NORCO Pipeline**
  -  Above ground
  -  Underground
- Outside Operations**
  -  Gulf South Pipeline
  -  Boss Pipeline
  -  Gathering Line 2'
  -  Plains Marketing Pipeline

Source: AOC and pipeline locations from TRC, dated, March 10, 2011

Image Source: 2009 Texas Orthoimagery Program, Texas Strategic Mapping Program, TNRIS, 2009



- Legend:**
-  Monitoring Well Location (2013)
  -  Soil Boring (2013)
  -  Area of Concern Boundary

Source: AOC and pipeline locations from TRC, dated, March 10, 2011

Image Source: 2009 Texas Orthoimagery Program, Texas Strategic Mapping Program, TNRIS, 2009



Falcon Refinery Superfund Site  
Ingleside, San Patricio County, Texas

**Figure 3**  
**AOC 4 Sample Locations**  
Human Health Risk Assessment for AOC-4



N

0 750 1,500  
Feet

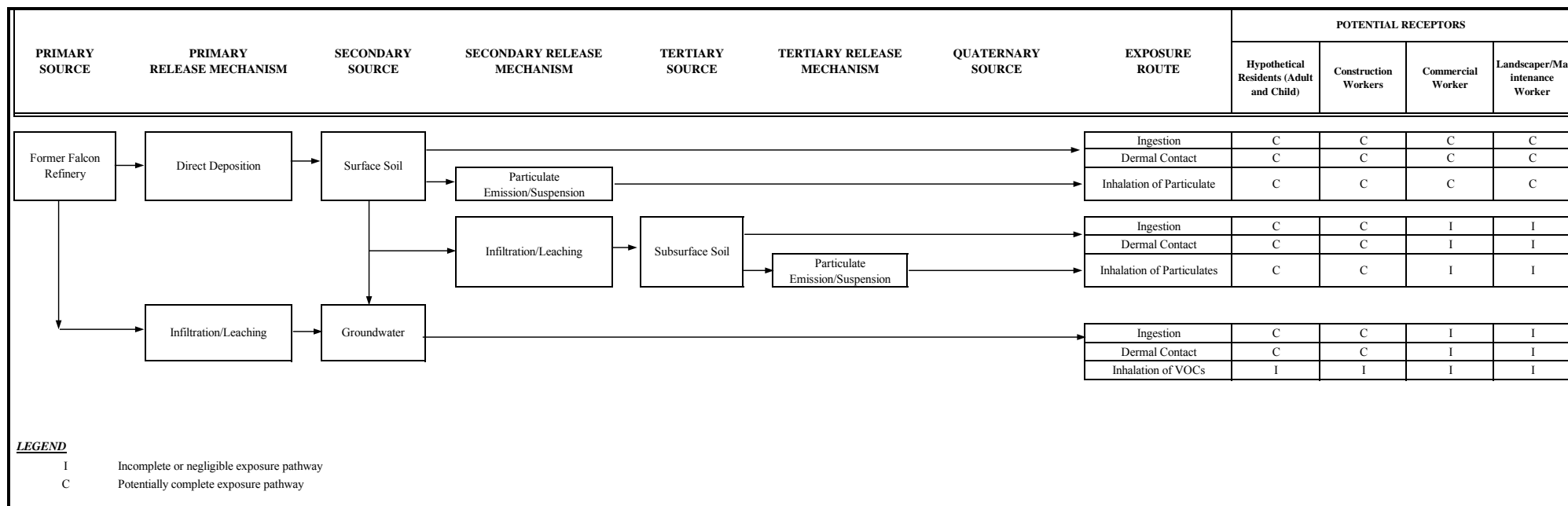
**Legend:**

- ◆ Sediment/Surface Water Sample Location
- ◆ Soil Sample Location
- Monitoring Well Location
- Temporary Well at Soil Sample Location
- Areas of Concern Boundary

Source: AOC and pipeline locations from TRC, dated, March 10, 2011

Image Source: 2009 Texas Orthoimagery Program, Texas Strategic Mapping Program, TNRIS, 2009

**FIGURE 5**  
**HUMAN HEALTH CONCEPTUAL SITE MODEL**  
**AOC-4, FALCON REFINERY SUPERFUND SITE**  
**INGLESIDE, SAN PATRICIO COUNTY, TEXAS**



## **TABLES**

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**TABLE 1**  
**OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN**  
**AOC-4, FALCON REFINERY SUPERFUND SITE - SURFACE SOIL - RESIDENTIAL**  
**INGLESIDE, SAN PATRICIO COUNTY, TEXAS**

Scenario Timeframe: Future-Residential  
Medium: Surface soil  
Exposure Medium: Surface soil  
Exposure Point: Falcon Refinery

CAS Number	Chemical	Minimum <sup>(1)</sup> Concentration	Minimum Qualifier	Maximum <sup>(1)</sup> Concentration	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration <sup>(2)</sup> Used for Screening	Background <sup>(3)</sup> Value	Screening <sup>(4)</sup> Toxicity Value	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for <sup>(5)</sup> Contaminant Deletion or Selection
<b>Inorganics</b>																
7429-90-5	Aluminum	2.00E+03		1.70E+04		mg/kg	SO4-01-0.0-0.5	6/6	0.00E+00 - 0.00E+00	1.70E+04	8.42E+03	7.70E+03	N	NA	NA	ASL
7440-38-2	Arsenic	9.40E-01		5.70E+00		mg/kg	SO4-01-0.0-0.5	6/6	0.00E+00 - 0.00E+00	5.70E+00	3.40E+00	6.10E-01	C	NA	NA	ASL
7440-39-3	Barium	8.14E+01		8.09E+02		mg/kg	SO4-01-0.0-0.5	6/6	0.00E+00 - 0.00E+00	8.09E+02	1.19E+03	1.50E+03	N	NA	NA	BSL
7440-43-9	Cadmium	9.00E-01		9.00E-01		mg/kg	SO4-01-0.0-0.5	1/6	0.00E+00 - 5.80E-01	9.00E-01	6.80E-01	7.00E+00	N	NA	NA	BSL
7440-70-2	Calcium	2.17E+04		2.64E+05		mg/kg	SO4-03-0.0-0.5	6/6	0.00E+00 - 0.00E+00	2.64E+05	5.73E+05	NA	NA	NA	NA	NUT
7440-47-3	Chromium	2.00E+00		1.76E+01	J	mg/kg	SO4-04-0.0-0.5	6/6	0.00E+00 - 0.00E+00	1.76E+01	NA	1.20E+04	N	NA	NA	BSL
7440-48-4	Cobalt	7.20E-01		3.80E+00		mg/kg	SO4-01-0.0-0.5	6/6	0.00E+00 - 0.00E+00	3.80E+00	3.35E+00	2.30E+00	N	NA	NA	ASL
7440-50-8	Copper	2.80E+00		3.98E+01		mg/kg	SO4-04-0.0-0.5	6/6	0.00E+00 - 0.00E+00	3.98E+01	2.84E+01	3.10E+02	N	NA	NA	BSL
7439-89-6	Iron	2.25E+03	J	1.30E+04		mg/kg	SO4-01-0.0-0.5	6/6	0.00E+00 - 0.00E+00	1.30E+04	2.07E+04	5.50E+03	N	NA	NA	ASL
7439-92-1	Lead	8.60E+00		4.30E+01		mg/kg	SO4-01-0.0-0.5	6/6	0.00E+00 - 0.00E+00	4.30E+01	5.02E+01	4.00E+02	N	NA	NA	BSL
7439-95-4	Magnesium	1.16E+03		6.01E+03		mg/kg	SO4-01-0.0-0.5	6/6	0.00E+00 - 0.00E+00	6.01E+03	4.22E+02	NA	NA	NA	NA	NUT
7439-96-5	Manganese	6.50E+01		2.59E+02	J	mg/kg	SO4-01-0.0-0.5	6/6	0.00E+00 - 0.00E+00	2.59E+02	3.27E+02	1.80E+02	N	NA	NA	ASL
7439-97-6	Mercury	1.30E-01		1.50E+00		mg/kg	SO4-01-0.0-0.5	6/6	0.00E+00 - 0.00E+00	1.50E+00	2.10E-02	2.30E+00	N	NA	NA	ASL
7440-02-0	Nickel	1.70E+00		1.85E+01		mg/kg	SO4-01-0.0-0.5	6/6	0.00E+00 - 0.00E+00	1.85E+01	1.30E+01	1.50E+02	N	NA	NA	BSL
7440-09-7	Potassium	6.05E+02		4.00E+03		mg/kg	SO4-01-0.0-0.5	6/6	0.00E+00 - 0.00E+00	4.00E+03	1.70E+03	NA	NA	NA	NA	NUT
7440-23-5	Sodium	6.25E+02		4.23E+03		mg/kg	MW-17-0.0-0.5	5/6	0.00E+00 - 4.49E+02	4.23E+03	NA	NA	NA	NA	NA	NUT
7440-62-2	Vanadium	3.40E+00		2.13E+01	J	mg/kg	SO4-01-0.0-0.5	6/6	0.00E+00 - 0.00E+00	2.13E+01	1.93E+01	3.90E+01	N	NA	NA	BSL
7440-66-6	Zinc	7.18E+01		5.60E+02		mg/kg	SO4-01-0.0-0.5	6/6	0.00E+00 - 0.00E+00	5.60E+02	3.63E+03	2.30E+03	N	NA	NA	BSL
<b>POLYAROMATIC HYDROCARBONS (PAH)</b>																
83-32-9	Acenaphthene	5.10E-03	LJ	3.20E-02	LJ	mg/kg	SO4-04-0.0-0.5	3/6	0.00E+00 - 7.30E-02	3.20E-02	NA	3.40E+02	N	NA	NA	BSL
208-96-8	Acenaphthylene	7.30E-03	LJ	6.10E-02	LJ	mg/kg	SO4-04-0.0-0.5	4/6	0.00E+00 - 7.20E-02	6.10E-02	NA	3.60E+00	C	NA	NA	BSL
120-12-7	Anthracene	1.30E-02	LJ	6.50E-02	LJ	mg/kg	SO4-04-0.0-0.5	5/6	0.00E+00 - 7.20E-02	6.50E-02	NA	1.70E+03	N	NA	NA	BSL
56-55-3	Benzo(a)anthracene	6.30E-02		5.90E-01		mg/kg	MW-17-0.0-0.5	6/6	0.00E+00 - 0.00E+00	5.90E-01	NA	1.50E-01	C	NA	NA	ASL
50-32-8	Benzo(a)pyrene	5.30E-02		5.00E-01		mg/kg	MW-17-0.0-0.5	6/6	0.00E+00 - 0.00E+00	5.00E-01	NA	1.50E-02	C	NA	NA	ASL
205-99-2	Benzo(b)fluoranthene	1.00E-01		8.20E-01		mg/kg	MW-17-0.0-0.5	6/6	0.00E+00 - 0.00E+00	8.20E-01	NA	1.50E-01	C	NA	NA	ASL
191-24-2	Benzo(g,h,i)perylene	2.20E-02		2.10E-01		mg/kg	SO4-04-0.0-0.5, MW-17-0.0-0.5	6/6	0.00E+00 - 0.00E+00	2.10E-01	NA	1.70E+02	N	NA	NA	BSL
207-08-9	Benzo(k)fluoranthene	2.80E-02		2.70E-01		mg/kg	SO4-04-0.0-0.5	6/6	0.00E+00 - 0.00E+00	2.70E-01	NA	1.50E+00	C	NA	NA	BSL
218-01-9	Chrysene	7.00E-02		6.00E-01		mg/kg	MW-17-0.0-0.5	6/6	0.00E+00 - 0.00E+00	6.00E-01	NA	1.50E+01	C	NA	NA	BSL
53-70-3	Dibenz(a,h)anthracene	1.00E-02		7.60E-02		mg/kg	MW-17-0.0-0.5	5/6	0.00E+00 - 7.20E-02	7.60E-02	NA	1.50E-02	C	NA	NA	ASL
206-44-0	Fluoranthene	1.60E-01		1.40E+00		mg/kg	MW-17-0.0-0.5	6/6	0.00E+00 - 0.00E+00	1.40E+00	NA	2.30E+02	N	NA	NA	BSL
86-73-7	Fluorene	3.70E-03	LJ	1.50E-02	LJ	mg/kg	MW-17-0.0-0.5	2/6	0.00E+00 - 7.40E-02	1.50E-02	NA	2.30E+02	N	NA	NA	BSL
193-39-5	Indeno(1,2,3-cd)pyrene	5.00E-02		3.50E-01		mg/kg	MW-17-0.0-0.5, SO4-04-0.0-0.5	6/6	0.00E+00 - 0.00E+00	3.50E-01	NA	1.50E-01	C	NA	NA	ASL
85-01-8	Phenanthrene	4.30E-02	LJ	3.50E-01		mg/kg	MW-17-0.0-0.5	6/6	0.00E+00 - 0.00E+00	3.50E-01	NA	1.70E+03	N	NA	NA	BSL
129-00-0	Pyrene	1.20E-01		1.10E+00		mg/kg	MW-17-0.0-0.5	6/6	0.00E+00 - 0.00E+00	1.10E+00	NA	1.70E+02	N	NA	NA	BSL
<b>SEMIVOLATILE ORGANIC COMPOUNDS (SVOC)</b>																
98-86-2	Acetophenone	6.20E-02	LJ	6.20E-02	LJ	mg/kg	SO4-05-0.0-0.5	1/6	0.00E+00 - 1.20E+00	6.20E-02	NA	7.80E+02	N	NA	NA	BSL
100-52-7	Benzaldehyde	6.60E-02	LJ	6.60E-02	LJ	mg/kg	SO4-05-0.0-0.5	1/6	0.00E+00 - 1.20E+00	6.60E-02	NA	7.80E+02	N	NA	NA	BSL
117-81-7	Bis(2-ethylhexyl) phthalate	9.40E-02	LJ	2.20E-01	LJ	mg/kg	SO4-04-0.0-0.5	2/6	0.00E+00 - 1.20E+00	2.20E-01	NA	3.50E+01	C	NA	NA	BSL
86-74-8	Carbazole	1.90E-02	LJ	1.90E-02	LJ	mg/kg	SO4-05-0.0-0.5	1/6	0.00E+00 - 1.20E+00	1.90E-02	NA	NA	NA	NA	NA	BSL
131-11-3	Dimethyl phthalate	2.00E-02	LJ	1.50E-01	LJ	mg/kg	SO4-04-0.0-0.5	2/6	0.00E+00 - 1.20E+00	1.50E-01	NA	NA	NA	NA	NA	BSL
108-95-2	Phenol	3.30E-02	LJ	3.30E-02	LJ	mg/kg	SO4-05-0.0-0.5	1/6	0.00E+00 - 1.20E+00	3.30E-02	NA	1.80E+03	N	NA	NA	BSL

Scenario Timeframe: Future-Residential Medium: Surface soil Exposure Medium: Surface soil Exposure Point: Falcon Refinery
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**TABLE 2**  
**OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN**  
**AOC-4, FALCON REFINERY SUPERFUND SITE - SUBSURFACE SOIL - RESIDENTIAL**  
**INGLESIDE, SAN PATRICIO COUNTY, TEXAS**

Scenario Timeframe: Future-Residential  
Medium: Subsurface soil  
Exposure Medium: Subsurface soil  
Exposure Point: Falcon Refinery

CAS Number	Chemical	Minimum <sup>(1)</sup> Concentration	Minimum Qualifier	Maximum <sup>(1)</sup> Concentration	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration <sup>(2)</sup> Used for Screening	Background <sup>(3)</sup> Value	Screening <sup>(4)</sup> Toxicity Value	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for <sup>(5)</sup> Contaminant Deletion or Selection
<b>Inorganics</b>																
7429-90-5	Aluminum	8.18E+02		3.79E+03		mg/kg	FR-135	12/12	0.00E+00 - 0.00E+00	3.79E+03	8.99E+03	7.70E+03	N	NA	NA	BSL
7440-38-2	Arsenic	4.10E-01	LJ	2.10E+00		mg/kg	MW-17-0.5-2.0	12/12	0.00E+00 - 0.00E+00	2.10E+00	9.90E-01	6.10E-01	C	NA	NA	Yes
7440-39-3	Barium	5.30E+00		2.03E+02		mg/kg	SO4-01-0.5-2.0	12/12	0.00E+00 - 0.00E+00	2.03E+02	7.77E+01	1.50E+03	N	NA	NA	BSL
7440-41-7	Beryllium	2.40E-01	B	2.40E-01	B	mg/kg	FR-135	1/12	0.00E+00 - 5.40E-01	2.40E-01	1.30E-01	1.60E+01	N	NA	NA	BSL
7440-70-2	Calcium	5.74E+02		1.46E+05	J	mg/kg	SO4-03-0.5-2.0	11/11	0.00E+00 - 0.00E+00	1.46E+05	3.46E+04	NA	NA	NA	No	NUT
7440-47-3	Chromium	5.80E-01	LJ	4.40E+00		mg/kg	FR-135	12/12	0.00E+00 - 0.00E+00	4.40E+00	3.35E+00	1.20E+04	N	NA	NA	BSL
7440-48-4	Cobalt	4.70E-01		9.70E-01		mg/kg	MW-17-0.5-2.0	8/12	0.00E+00 - 5.40E-01	9.70E-01	3.20E+00	2.30E+00	N	NA	NA	BSL
7440-50-8	Copper	5.90E-01	LJ	4.10E+00		mg/kg	SO4-01-0.5-2.0	9/12	0.00E+00 - 1.10E+00	4.10E+00	2.60E+00	3.10E+02	N	NA	NA	BSL
7439-89-6	Iron	7.61E+02	J	3.13E+03		mg/kg	SO4-05-2.0-3.0	12/12	0.00E+00 - 0.00E+00	3.13E+03	NA	5.50E+03	N	NA	NA	BSL
7439-92-1	Lead	7.70E-01		1.58E+01		mg/kg	MW-17-2.0-3.5	12/12	0.00E+00 - 0.00E+00	1.58E+01	1.10E+01	4.00E+02	N	NA	NA	BSL
7439-95-4	Magnesium	1.88E+02	LJ	2.09E+03		mg/kg	SO4-05-2.0-3.0	11/11	0.00E+00 - 0.00E+00	2.09E+03	9.93E+02	NA	NA	NA	No	NUT
7439-96-5	Manganese	7.50E+00		1.20E+02	J	mg/kg	SO4-03-0.5-2.0	12/12	0.00E+00 - 0.00E+00	1.20E+02	NA	1.80E+02	N	NA	NA	BSL
7439-97-6	Mercury	6.00E-03	LJ	2.30E+00	J	mg/kg	SO4-02-0.5-2.0	11/12	0.00E+00 - 1.10E-01	2.30E+00	1.26E-02	2.30E+00	N	NA	NA	Yes
7440-02-0	Nickel	3.40E-01	LJ	1.80E+00		mg/kg	SO4-05-2.0-3.0	12/12	0.00E+00 - 0.00E+00	1.80E+00	2.24E+00	1.50E+02	N	NA	NA	BSL
7440-09-7	Potassium	3.02E+02	LJ	1.11E+03		mg/kg	SO4-05-2.0-3.0	9/11	0.00E+00 - 4.63E+02	1.11E+03	1.16E+03	NA	NA	NA	No	NUT
7782-49-2	Selenium	2.90E-01	B	2.90E-01	B	mg/kg	FR-135	1/12	0.00E+00 - 2.70E+00	2.90E-01	NA	3.90E+01	N	NA	NA	BSL
7440-23-5	Sodium	3.21E+02	LJ	1.33E+03		mg/kg	MW-17-0.5-2.0	10/11	0.00E+00 - 4.08E+02	1.33E+03	3.73E+02	NA	NA	NA	No	NUT
7440-62-2	Vanadium	1.60E+00	LJ	5.70E+00	B	mg/kg	FR-135	10/12	0.00E+00 - 2.60E+00	5.70E+00	5.37E+00	3.90E+01	N	NA	NA	BSL
7440-66-6	Zinc	4.20E+00		7.91E+01		mg/kg	SO4-02-0.5-2.0	11/12	0.00E+00 - 9.60E-01	7.91E+01	1.10E+01	2.30E+03	N	NA	NA	BSL
<b>POLYAROMATIC HYDROCARBONS (PAH)</b>																
91-57-6	2-Methylnaphthalene	1.90E-03	LJ	1.90E-03	LJ	mg/kg	MW-17-0.5-2.0	1/11	0.00E+00 - 1.10E-01	1.90E-03	NA	2.30E+01	N	NA	NA	BSL
83-32-9	Acenaphthene	1.30E-02		1.10E-01		mg/kg	SO4-04-2.0-3.0	2/11	0.00E+00 - 1.10E-01	1.10E-01	NA	3.40E+02	N	NA	NA	BSL
208-96-8	Acenaphthylene	2.70E-03	LJ	1.20E-02	LJ	mg/kg	SO4-04-2.0-3.0	6/11	0.00E+00 - 1.10E-01	1.20E-02	NA	3.60E+00	C	NA	NA	BSL
120-12-7	Anthracene	1.60E-03	LJ	1.30E-01		mg/kg	SO4-05-0.5-2.0	9/11	0.00E+00 - 4.00E-03	1.30E-01	NA	1.70E+03	N	NA	NA	BSL
56-55-3	Benzo(a)anthracene	4.50E-03		2.30E-01		mg/kg	SO4-05-0.5-2.0	9/11	0.00E+00 - 4.00E-03	2.30E-01	NA	1.50E-01	C	NA	NA	Yes
50-32-8	Benzo(a)pyrene	3.30E-03	LJ	2.50E-01		mg/kg	SO4-05-0.5-2.0	9/11	0.00E+00 - 4.00E-03	2.50E-01	NA	1.50E-02	C	NA	NA	Yes
205-99-2	Benzo(b)fluoranthene	4.80E-03		2.80E-01		mg/kg	SO4-05-0.5-2.0	9/11	0.00E+00 - 4.00E-03	2.80E-01	NA	1.50E-01	C	NA	NA	Yes
191-24-2	Benzo(g,h,i)perylene	1.70E-03	LJ	8.90E-02	LJ	mg/kg	SO4-05-0.5-2.0	8/11	0.00E+00 - 4.00E-03	8.90E-02	NA	1.70E+02	N	NA	NA	BSL
207-08-9	Benzo(k)fluoranthene	1.70E-03	LJ	1.30E-01		mg/kg	SO4-05-0.5-2.0	9/11	0.00E+00 - 4.00E-03	1.30E-01	NA	1.50E+00	C	NA	NA	BSL
218-01-9	Chrysene	4.20E-03		2.10E-01		mg/kg	SO4-05-0.5-2.0	9/11	0.00E+00 - 4.00E-03	2.10E-01	NA	1.50E+01	C	NA	NA	BSL
53-70-3	Dibenz(a,h)anthracene	2.00E-03	LJ	2.80E-02		mg/kg	MW-17-0.5-2.0	6/11	0.00E+00 - 1.10E-01	2.80E-02	NA	1.50E-02	C	NA	NA	Yes
206-44-0	Fluoranthene	8.70E-03		4.80E-01		mg/kg	SO4-05-0.5-2.0	9/11	0.00E+00 - 4.00E-03	4.80E-01	NA	2.30E+02	N	NA	NA	BSL
86-73-7	Fluorene	7.60E-03		7.60E-03		mg/kg	MW-17-0.5-2.0	1/11	0.00E+00 - 1.10E-01	7.60E-03	NA	2.30E+02	N	NA	NA	BSL
193-39-5	Indeno(1,2,3-cd)pyrene	2.50E-03	LJ	2.00E-01		mg/kg	SO4-05-0.5-2.0	9/11	0.00E+00 - 4.00E-03	2.00E-01	NA	1.50E-01	C	NA	NA	Yes
91-20-3	Naphthalene	1.90E-03	LJ	2.50E-03	LJ	mg/kg	MW-17-0.5-2.0	2/11	0.00E+00 - 1.10E-01	2.50E-03	NA	3.60E+00	C	NA	NA	BSL
85-01-8	Phenanthrene	6.60E-03		3.00E-01		mg/kg	SO4-05-0.5-2.0	8/11	0.00E+00 - 7.30E-03	3.00E-01	NA	1.70E+03	N	NA	NA	BSL
129-00-0	Pyrene	9.00E-03		3.80E-01		mg/kg	SO4-05-0.5-2.0	9/11	0.00E+00 - 4.00E-03	3.80E-01	NA	1.70E+02	N	NA	NA	BSL
<b>SEMIVOLATILE ORGANIC COMPOUNDS (SVOC)</b>																
98-86-2	Acetophenone	2.00E-02	LJ	7.80E-02	LJ	mg/kg	SO4-05-0.5-2.0	5/11	0.00E+00 - 1.00E+00	7.80E-02	NA	7.80E+02	N	NA	NA	BSL
100-52-7	Benzaldehyde	2.30E-02	LJ	7.40E-02	LJ	mg/kg	SO4-05-0.5-2.0	5/11	0.00E+00 - 1.00E+00	7.40E-02	NA	7.80E+02	N	NA	NA	BSL
117-81-7	Bis(2-ethylhexyl) phthalate	2.20E-02	LJ	1.33E-01	J	mg/kg	FR-135	2/12	0.00E+00 - 1.00E+00	1.33E-01	NA	3.50E+01	C	NA	NA	BSL
86-74-8	Carbazole	2.60E-02	LJ	3.20E-02	LJ	mg/kg	MW-17-0.5-2.0	2/11	0.00E+00 - 1.00E+00	3.20E-02	NA	NA	NA	NA	No	BSL
131-11-3	Dimethyl phthalate	2.20E-02	LJ	2.20E-02	LJ	mg/kg	MW-17-2.0-3.5	1/11	0.00E+00 - 1.00E+00	2.20E-02	NA	NA	NA	NA	No	BSL

**TABLE 2**  
**OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN**  
**AOC-4, FALCON REFINERY SUPERFUND SITE - SUBSURFACE SOIL - RESIDENTIAL**  
**INGLESIDE, SAN PATRICIO COUNTY, TEXAS**

Scenario Timeframe: Future-Residential  
Medium: Subsurface soil  
Exposure Medium: Subsurface soil  
Exposure Point: Falcon Refinery

CAS Number	Chemical	Minimum <sup>(1)</sup> Concentration	Minimum Qualifier	Maximum <sup>(1)</sup> Concentration	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration <sup>(2)</sup> Used for Screening	Background <sup>(3)</sup> Value	Screening <sup>(4)</sup> Toxicity Value	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for <sup>(5)</sup> Contaminant Deletion or Selection
<b>VOLATILE ORGANIC COMPOUNDS (VOC)</b>																
67-64-1	Acetone	6.00E-03	LJ	9.10E-03	J	mg/kg	FR-135	5/12	0.00E+00 - 1.50E-02	9.10E-03	NA	6.10E+03	N	NA	NA	BSL
75-15-0	Carbon disulfide	3.90E-04	LJ	3.90E-04	LJ	mg/kg	SO4-01-2.0-3.0	1/11	0.00E+00 - 7.70E-03	3.90E-04	NA	8.20E+01	N	NA	NA	BSL
67-66-3	Chloroform	5.50E-04	LJ	5.50E-04	LJ	mg/kg	SO4-04-2.0-3.0	1/11	0.00E+00 - 7.70E-03	5.50E-04	NA	2.90E-01	C	NA	NA	BSL
179601-23-1	m- & p-Xylenes	1.40E-04	LJ	6.70E-04	LJ	mg/kg	SO4-04-0.5-2.0	5/11	0.00E+00 - 6.20E-03	6.70E-04	NA	NA	NA	NA	NA	BSL
75-09-2	Methylene chloride	3.50E-03	J	3.50E-03	J	mg/kg	FR-135	1/12	0.00E+00 - 7.70E-03	3.50E-03	NA	3.60E+01	N	NA	NA	BSL
1634-04-4	Methyl-tertiary-butyl ether (MtBE)	9.60E-04	LJ	9.60E-04	LJ	mg/kg	SO4-05-2.0-3.0	1/11	0.00E+00 - 7.70E-03	9.60E-04	NA	4.30E+01	C	NA	NA	BSL
75-69-4	Trichlorofluoromethane	1.40E-04	LJ	3.50E-04	LJ	mg/kg	SO4-01-0.5-2.0	8/11	0.00E+00 - 6.20E-03	3.50E-04	NA	7.90E+01	N	NA	NA	BSL
<p>NOTE:</p> <p>(1) Minimum/maximum detected concentration.</p> <p>(2) Maximum concentration used as screening value.</p> <p>(3) Background values are not included as part of the COPC selection process.</p> <p>(4) USEPA Regional Screening Levels, USEPA, November 2013. For non-carcinogens, value shown is equal to 1/10 the residential soil value. For carcinogens the value shown is equal to the residential soil value.</p> <p>(5) Rationale Codes</p> <div> <div>Selection Reason:</div> <div>Deletion Reason:</div> </div> <div> <div>ASL = Above Screening Toxicity Level</div> <div>BSL = Below Screening Toxicity Level</div> <div>NSL = No Screening Toxicity Level</div> <div>NUT = Essential Nutrient</div> </div> <div> <p>Definitions:</p> <p>C = Carcinogenic</p> <p>COPC = Chemical of Potential Concern</p> <p>N = Non-Carcinogenic</p> <p>NA = Not Applicable</p> <p>mg/kg = milligrams per kilogram</p> <p>Data Qualifiers:</p> <p>B = Indicates analyte detected in associated method blank</p> <p>J = Indicates an estimated value</p> </div> <p>Surrogates used: Chromium(III) for Chromium, Methyl Mercury for Mercury, Anthracene for Phenanthrene, Naphthalene for Acenaphthylene, Pyrene for Benzo(g,h,i)perylene.</p>																

**TABLE 3**  
**OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN**  
**AOC-4, FALCON REFINERY SUPERFUND SITE - GROUND WATER**  
**INGLESIDE, SAN PATRICIO COUNTY, TEXAS**

Scenario Timeframe: Future
Medium: Ground water
Exposure Medium: Ground water
Exposure Point: Falcon Refinery

CAS Number	Chemical	Minimum <sup>(1)</sup> Concentration	Minimum Qualifier	Maximum <sup>(1)</sup> Concentration	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration <sup>(2)</sup> Used for Screening	Background <sup>(3)</sup> Value	Screening <sup>(4)</sup> Toxicity Value	Potential <sup>(5)</sup> ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for <sup>(6)</sup> Contaminant Deletion or Selection	
INORGANICS-DISSOLVED																	
7440-38-2	Arsenic	6.08E+01		6.08E+01		ug/L	MW-17	1/1	0.00E+00 - 0.00E+00	6.08E+01	1.49E+01	4.50E-02	C	1.00E+01	MCL	Yes	ASL
7440-39-3	Barium	1.24E+02		1.24E+02		ug/L	MW-17	1/1	0.00E+00 - 0.00E+00	1.24E+02	2.93E+02	2.90E+02	N	2.00E+03	MCL	No	BSL
7440-70-2	Calcium	8.04E+04		8.04E+04		ug/L	MW-17	1/1	0.00E+00 - 0.00E+00	8.04E+04	1.47E+05	NA	NA	NA	No	NUT	
7439-89-6	Iron	3.19E+02		3.19E+02		ug/L	MW-17	1/1	0.00E+00 - 0.00E+00	3.19E+02	1.72E+04	1.10E+03	N	NA	NA	No	BSL
7439-95-4	Magnesium	1.28E+05		1.28E+05		ug/L	MW-17	1/1	0.00E+00 - 0.00E+00	1.28E+05	5.39E+04	NA	NA	NA	No	NUT	
7439-96-5	Manganese	1.33E+02		1.33E+02		ug/L	MW-17	1/1	0.00E+00 - 0.00E+00	1.33E+02	3.66E+02	3.20E+01	N	NA	NA	Yes	ASL
7440-02-0	Nickel	5.80E+00		5.80E+00		ug/L	MW-17	1/1	0.00E+00 - 0.00E+00	5.80E+00	1.52E+01	3.00E+01	N	NA	NA	No	BSL
7440-09-7	Potassium	1.07E+05		1.07E+05		ug/L	MW-17	1/1	0.00E+00 - 0.00E+00	1.07E+05	1.57E+04	NA	NA	NA	No	NUT	
7440-23-5	Sodium	1.47E+06		1.47E+06		ug/L	MW-17	1/1	0.00E+00 - 0.00E+00	1.47E+06	3.34E+05	NA	NA	NA	No	NUT	
INORGANICS-TOTAL																	
7429-90-5	Aluminum	1.65E+02	LJ	1.65E+02	LJ	ug/L	MW-17	1/1	0.00E+00 - 0.00E+00	1.65E+02	1.13E+03	1.60E+03	N	NA	NA	No	BSL
7440-38-2	Arsenic	6.04E+01		6.04E+01		ug/L	MW-17	1/1	0.00E+00 - 0.00E+00	6.04E+01	1.38E+01	4.50E-02	C	1.00E+01	MCL	Yes	ASL
7440-39-3	Barium	1.24E+02		1.24E+02		ug/L	MW-17	1/1	0.00E+00 - 0.00E+00	1.24E+02	2.96E+02	2.90E+02	N	2.00E+03	MCL	No	BSL
7440-70-2	Calcium	9.13E+04		9.13E+04		ug/L	MW-17	1/1	0.00E+00 - 0.00E+00	9.13E+04	1.60E+05	NA	NA	NA	No	NUT	
7439-89-6	Iron	4.79E+02		4.79E+02		ug/L	MW-17	1/1	0.00E+00 - 0.00E+00	4.79E+02	1.77E+04	1.10E+03	N	NA	NA	No	BSL
7439-95-4	Magnesium	1.21E+05		1.21E+05		ug/L	MW-17	1/1	0.00E+00 - 0.00E+00	1.21E+05	8.26E+04	NA	NA	NA	No	NUT	
7439-96-5	Manganese	1.34E+02		1.34E+02		ug/L	MW-17	1/1	0.00E+00 - 0.00E+00	1.34E+02	6.59E+02	3.20E+01	N	NA	NA	Yes	ASL
7440-02-0	Nickel	4.20E+00	LJ	4.20E+00	LJ	ug/L	MW-17	1/1	0.00E+00 - 0.00E+00	4.20E+00	1.52E+01	3.00E+01	N	NA	NA	No	BSL
7440-09-7	Potassium	1.16E+05		1.16E+05		ug/L	MW-17	1/1	0.00E+00 - 0.00E+00	1.16E+05	2.90E+04	NA	NA	NA	No	NUT	
7782-49-2	Selenium	2.90E+00	LJ	2.90E+00	LJ	ug/L	MW-17	1/1	0.00E+00 - 0.00E+00	2.90E+00	3.70E+00	7.80E+00	N	5.00E+01	MCL	No	BSL
7440-23-5	Sodium	1.29E+06	J	1.29E+06	J	ug/L	MW-17	1/1	0.00E+00 - 0.00E+00	1.29E+06	5.20E+05	NA	NA	NA	No	NUT	
VOLATILE ORGANIC COMPOUNDS (VOC)																	
106-46-7	1,4-Dichlorobenzene	1.40E-01	LJ	1.40E-01	LJ	ug/L	MW-17	1/1	0.00E+00 - 0.00E+00	1.40E-01	NA	4.20E-01	C	7.50E+01	MCL	No	BSL
NOTE:																	
(1) Minimum/maximum detected concentration.										Definitions:  C = Carcinogenic COPC = Chemical of Potential Concern N = Non-Carcinogenic NA = Not Applicable  ug/L = micrograms per liter  ARAR = Applicable or Relevant and Appropriate Requirement							
(2) Maximum concentration used as screening value.																	
(3) Background values are not included as part of the COPC selection process.																	
(4) USEPA Regional Screening Levels, USEPA, November 2013. For non-carcinogens, value shown is equal to 1/10 the tap water value. For carcinogens the value shown is equal to the tap water value.																	
(5) ARAR value is the Texas Commission on Environmental Quality, Drinking Water Standards, Chapter 290, Maximum Contaminant Level (MCL).																	
(6) Rationale Codes                      Selection Reason:                      ASL = Above Screening Toxicity Level																	

**TABLE 4**  
**MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY**  
**AOC-4, FALCON REFINERY SUPERFUND SITE - SURFACE SOIL - RESIDENTIAL**  
**INGLESIDE, SAN PATRICIO COUNTY, TEXAS**

Scenario Timeframe: Future-Residential
Medium: Surface soil
Exposure Medium: Surface soil
Exposure Point: Falcon Refinery

Chemical of Potential Concern	Units	Mean Detected Concentration	95% UCLM	Maximum Detected Concentration	Maximum Qualifier	EPC Units	Reasonable Maximum Exposure		
							Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale
INORGANICS									
Aluminum	mg/kg	5.17E+03	1.56E+04	1.70E+04	J	mg/kg	1.56E+04	95%UCLM-C	ProUCL
Arsenic	mg/kg	2.24E+00	4.27E+00	5.70E+00		mg/kg	4.27E+00	95%UCLM-G	ProUCL
Cobalt	mg/kg	1.58E+00	2.95E+00	3.80E+00		mg/kg	2.95E+00	95%UCLM-G	ProUCL
Iron	mg/kg	5.64E+03	8.95E+03	1.30E+04		mg/kg	8.95E+03	95%UCLM-N	ProUCL
Manganese	mg/kg	1.29E+02	1.85E+02	2.59E+02		mg/kg	1.85E+02	95%UCLM-N	ProUCL
Mercury	mg/kg	5.07E-01	1.18E+00	1.50E+00		mg/kg	1.18E+00	95%UCLM-G	ProUCL
POLYAROMIC HYDROCARBONS (PAH)									
Benzo(a)anthracene	mg/kg	2.37E-01	1.44E+00	5.90E-01		mg/kg	5.90E-01	Maximum	UCLM>Max
Benzo(a)pyrene	mg/kg	2.24E-01	3.87E-01	5.00E-01		mg/kg	3.87E-01	95%UCLM-N	ProUCL
Benzo(b)fluoranthene	mg/kg	3.90E-01	9.03E-01	8.20E-01		mg/kg	8.20E-01	Maximum	UCLM>Max
Dibenz(a,h)anthracene	mg/kg	4.72E-02	6.98E-02	7.60E-02		mg/kg	6.98E-02	95%UCLM-KMt	ProUCL
Indeno(1,2,3-cd)pyrene	mg/kg	1.80E-01	2.92E-01	3.50E-01		mg/kg	2.92E-01	95%UCLM-N	ProUCL
NOTE:									
Statistics calculated by the EPA program ProUCL. Outputs are provided in Appendix C.									
95%UCLM-C indicates that the 95 percent upper confidence limit on the mean is based on the non-parametric Chebyshev test.									
95%UCLM-G indicates that the 95 percent upper confidence limit on the mean is based on the approximate or adjusted gamma distribution.									
95%UCLM-KMt indicates that the 95 percent upper confidence limit on the mean is based on the non-parametric Kaplan-Meier (KM) student's t-test.									
95%UCLM-N indicates that the 95 percent upper confidence limit on the mean is based on the student's t-test for normal distributions.									
UCLM>Maximum indicates that the recommended 95 UCL exceeds the maximum detected value, therefore the maximum detected value is used.									
NA = Not Applicable									

**TABLE 5**  
**MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY**  
**AOC-4, FALCON REFINERY SUPERFUND SITE - SUBSURFACE SOIL - RESIDENTIAL**  
**INGLESIDE, SAN PATRICIO COUNTY, TEXAS**

Scenario Timeframe: Future-Residential Medium: Subsurface soil Exposure Medium: Subsurface soil Exposure Point: Falcon Refinery
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Chemical of Potential Concern	Units	Mean Detected Concentration	95% UCLM	Maximum Detected Concentration	Maximum Qualifier	EPC Units	Reasonable Maximum Exposure		
							Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale
INORGANICS									
Arsenic	mg/kg	1.02E+00	1.27E+00	2.10E+00		mg/kg	1.27E+00	95%UCLM-N	ProUCL
Mercury	mg/kg	2.58E-01	2.12E+00	2.30E+00	J	mg/kg	2.12E+00	95%UCLM-KMC	ProUCL
PAH									
Benzo(a)anthracene	mg/kg	6.18E-02	1.56E-01	2.30E-01		mg/kg	1.56E-01	95%UCLM-KMC	ProUCL
Benzo(a)pyrene	mg/kg	6.04E-02	1.53E-01	2.50E-01		mg/kg	1.53E-01	95%UCLM-KMC	ProUCL
Benzo(b)fluoranthene	mg/kg	9.43E-02	2.16E-01	2.80E-01		mg/kg	2.16E-01	95%UCLM-KMC	ProUCL
Dibenz(a,h)anthracene	mg/kg	9.63E-03	1.18E-02	2.80E-02		mg/kg	1.18E-02	95%UCLM-KMp	ProUCL
Indeno(1,2,3-cd)pyrene	mg/kg	4.99E-02	1.22E-01	2.00E-01		mg/kg	1.22E-01	95%UCLM-KMC	ProUCL
NOTE:									
Statistics calculated by the EPA program ProUCL. Outputs are provided in Appendix C.									
95%UCLM-KMC indicates that the 95 percent upper confidence limit on the mean is based on the non-parametric Kaplan-Meier (KM) Chebyshev test.									
95%UCLM-KMp indicates that the 95 percent upper confidence limit on the mean is based on the non-parametric Kaplan-Meier (KM) percentile bootstrap test.									
95%UCLM-N indicates that the 95 percent upper confidence limit on the mean is based on the student's t-test for normal distributions.									

**TABLE 6**  
**MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY**  
**AOC-4, FALCON REFINERY SUPERFUND SITE - GROUND WATER**  
**INGLESIDE, SAN PATRICIO COUNTY, TEXAS**

Scenario Timeframe: Future Medium: Ground water Exposure Medium: Ground water Exposure Point: Falcon Refinery
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Chemical of Potential Concern	Units	Mean Detected Concentration	95% UCLM	Maximum Detected Concentration	Maximum Qualifier	EPC Units	Reasonable Maximum Exposure		
							Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale
INORGANICS-DISSOLVED									
Arsenic	ug/L	NA	NA	6.08E+01		ug/L	6.08E+01	Maximum	N < 5
Manganese	ug/L	NA	NA	1.33E+02		ug/L	1.33E+02	Maximum	N < 5
INORGANICS-TOTAL									
Arsenic	ug/L	NA	NA	6.04E+01		ug/L	6.04E+01	Maximum	N < 5
Manganese	ug/L	NA	NA	1.34E+02		ug/L	1.34E+02	Maximum	N < 5
NOTE:									
N < 5 indicates that the number of samples is less than 5, so the maximum detected value was used.									
NA = Not Applicable									

**TABLE 7**  
**VALUES USED FOR RESIDENT ADULT DAILY SOIL INTAKE EQUATIONS**  
**AOC-4, FALCON REFINERY SUPERFUND SITE**  
**INGLESIDE, SAN PATRICIO COUNTY, TEXAS**

Scenario Timeframe: Future  
Medium: Soil  
Exposure Medium: Soil, Air  
Exposure Point: AOC-4  
Receptor Population: Resident  
Receptor Age: Adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/Reference	Intake Equation / Model Name
Ingestion	CS	Chemical Concentration in Soil	mg/kg	Chemical-Specific	Chemical-Specific	Chronic Daily Intake (CDI) (mg/kg/day) = $CS \times CR \times EF \times ED \times CF / (BW \times AT)$  Mutagenic Chronic Daily Intake (MCDI) (mg/kg/day) = $CS \times EF \times [(ED_{6-16} \times CR \times 3) + (ED_{16-30} \times CR \times 1)] / (BW) \times CF / (AT)$
	CR	Ingestion Rate	mg/day	100	U.S. EPA 1991a	
	EF	Exposure Frequency	day/yr	350	U.S. EPA 1991a	
	ED-NC	Exposure Duration - Noncancer	yr	30	U.S. EPA 1991a	
	ED-C	Exposure Duration - Cancer	yr	24	U.S. EPA 1991a	
	BW	Body Weight	kg	70	U.S. EPA 1989	
	AT-NC	Averaging time - Noncancer	days	10,950	U.S. EPA 1989	
	AT-C	Averaging Time - Cancer	days	25,550	U.S. EPA 1989	
	CF	Conversion Factor	kg/mg	1.0E-06	U.S. EPA 1989	
Dermal	CS	Chemical Concentration in Soil	mg/kg	Chemical-Specific	Chemical-Specific	CDI (mg/kg/day) = $CS \times SA \times AF \times ABS \times EF \times ED \times CF / (BW \times AT)$  Mutagenic Chronic Daily Intake (MCDI) (mg/kg/day) = $CS \times EF \times ABS \times [(ED_{6-16} \times SA \times AF \times 3) + (ED_{16-30} \times SA \times AF \times 1)] / (BW) \times CF / (AT)$
	SA	Surface Area for Contact	cm <sup>2</sup> /event	5,700	U.S. EPA 2004 (1)	
	AF	Adherence Factor	mg/cm <sup>2</sup>	0.07	U.S. EPA 2004 (1)	
	EF	Exposure Frequency	event/yr	350	U.S. EPA 1991a	
	ED-NC	Exposure Duration - Noncancer	yr	30	U.S. EPA 1991a	
	ED-C	Exposure Duration - Cancer	yr	24	U.S. EPA 1991a	
	BW	Body Weight	kg	70	U.S. EPA 1991a	
	AT-NC	Averaging time - Noncancer	days	10,950	U.S. EPA 1989	
	AT-C	Averaging Time - Cancer	days	25,550	U.S. EPA 1989	
	CF	Conversion Factor	kg/mg	1.0E-06	U.S. EPA 1989	
	ABS	Dermal Absorption Fraction	unitless	Chemical-Specific	U.S. EPA 2004 (2)	
Inhalation	CA	Chemical Concentration in Air	mg/m <sup>3</sup>	Chemical-Specific	Chemical-Specific	Exposure Concentration (µg/m <sup>3</sup> or mg/m <sup>3</sup> ) = $CA \times CF_1 \times ET \times EF \times ED / AT \times CF_2$ Note: CF <sub>1</sub> only used in carcinogenic intake calculations  Mutagenic Exposure Concentration (MEC) (µg/m <sup>3</sup> ) = $CA \times ET \times EF \times [(ED_{6-16} \times 3) + (ED_{16-30} \times 1)] \times CF_1 / (AT \times CF_2)$
	CF <sub>1</sub>	Conversion Factor	µg/mg	1,000	U.S. EPA 2009a	
	ET	Exposure Time	hr/day	24	U.S. EPA 2009a	
	EF	Exposure Frequency	day/yr	350	U.S. EPA 1991a	
	ED-NC	Exposure Duration - Noncancer	yr	30	U.S. EPA 1991a	
	ED-C	Exposure Duration - Cancer	yr	24	U.S. EPA 1991a	
	BW	Body Weight	kg	70	U.S. EPA 1989	
	AT-NC	Averaging time - Noncancer	days	10,950	U.S. EPA 1989	
	AT-C	Averaging Time - Cancer	days	25,550	U.S. EPA 1989	
	CF <sub>2</sub>	Conversion Factor	hour/day	24	U.S. EPA 2009a	
<p>NOTE:</p> <p>(1) Taken from Exhibit 3-5 of USEPA 2004.</p> <p>(2) Taken from Exhibit 3-4 of USEPA 2004.</p> <p>BPJ = Best Professional Judgment</p> <p>U.S. EPA = United States Environmental Protection Agency</p> <p>CDI = chronic daily intake</p> <p>mg/kg = milligrams per kilogram</p> <p>kg/mg = kilograms per milligram</p> <p>mg/cm<sup>2</sup> = milligrams per square centimeter</p> <p>mg/day = milligrams per day</p> <p>day/yr = days per year</p> <p>RME = Reasonable Maximum Exposure</p> <p>mg/m<sup>3</sup> = milligram per cubic meter</p> <p>µg/m<sup>3</sup> = micrograms per cubic meter</p> <p>cm<sup>2</sup>/event = square centimeters per event</p> <p>µg/mg = microgram per milligram</p> <p>kg = kilogram</p> <p>hr/day = hours per day</p>						

**TABLE 8**  
**VALUES USED FOR RESIDENT CHILD DAILY SOIL INTAKE EQUATIONS**  
**AOC-4, FALCON REFINERY SUPERFUND SITE**  
**INGLESIDE, SAN PATRICIO COUNTY, TEXAS**

Scenario Timeframe: Future Medium: Soil Exposure Medium: Soil, Air Exposure Point: AOC-4 Receptor Population: Resident Receptor Age: Child
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Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/Reference	Intake Equation / Model Name
Ingestion	CS	Chemical Concentration in Soil	mg/kg	Chemical-Specific	Chemical-Specific	Chronic Daily Intake (CDI) (mg/kg/day) = $CS \times CR \times EF \times ED \times CF / (BW \times AT)$  Mutagenic Chronic Daily Intake (MCDI) (mg/kg/day) = $CS \times EF \times [(ED_{0.2} \times CR \times 10) + (ED_{2.6} \times CR \times 3)] / BW \times CF / (AT)$
	CR	Ingestion Rate	mg/day	200	U.S. EPA 2011a	
	EF	Exposure Frequency	day/yr	350	U.S. EPA 1991a	
	ED-NC	Exposure Duration - Noncancer	yr	6	U.S. EPA 1991a	
	ED-C	Exposure Duration - Cancer	yr	6	U.S. EPA 1991a	
	BW	Body Weight	kg	15	U.S. EPA 1989	
	AT-NC	Averaging time - Noncancer	days	2,190	U.S. EPA 1989	
	AT-C	Averaging Time - Cancer	days	25,550	U.S. EPA 1989	
	CF	Conversion Factor	kg/mg	1.0E-06	U.S. EPA 1989	
Dermal	CS	Chemical Concentration in Soil	mg/kg	Chemical-Specific	Chemical-Specific	CDI (mg/kg/day) = $CS \times SA \times AF \times ABS \times EF \times ED \times CF / (BW \times AT)$  Mutagenic Chronic Daily Intake (MCDI) (mg/kg/day) = $CS \times EF \times ABS \times [(ED_{0.2} \times SA \times AF \times 10) + (ED_{2.6} \times SA \times AF \times 3)] / BW \times CF / (AT)$
	SA	Surface Area for Contact	cm <sup>2</sup> /event	2,800	U.S. EPA 2004 (1)	
	AF	Adherence Factor	mg/cm <sup>2</sup>	0.2	U.S. EPA 2004 (1)	
	EF	Exposure Frequency	event/yr	350	U.S. EPA 1991a	
	ED-NC	Exposure Duration - Noncancer	yr	6	U.S. EPA 1991a	
	ED-C	Exposure Duration - Cancer	yr	6	U.S. EPA 1991a	
	BW	Body Weight	kg	15	U.S. EPA 1989	
	AT-NC	Averaging time - Noncancer	days	2,190	U.S. EPA 1989	
	AT-C	Averaging Time - Cancer	days	25,550	U.S. EPA 1989	
	CF	Conversion Factor	kg/mg	1.0E-06	U.S. EPA 1989	
	ABS	Dermal Absorption Fraction	unitless	Chemical-Specific	U.S. EPA 2004 (2)	
Inhalation	CA	Chemical Concentration in Air	mg/m <sup>3</sup>	Chemical-Specific	Chemical-Specific	Exposure Concentration (µg/m <sup>3</sup> or mg/m <sup>3</sup> ) = $CA \times CF_1 \times ET \times EF \times ED / AT \times CF_2$ Note: CF <sub>1</sub> only used in carcinogenic intake calculations  Mutagenic Exposure Concentration (MEC) (µg/m <sup>3</sup> ) = $CA \times ET \times EF \times [(ED_{0.2} \times 10) + (ED_{2.6} \times 3)] \times CF_1 / (AT \times CF_2)$
	CF <sub>1</sub>	Conversion Factor	µg/mg	1,000	U.S. EPA 2009a	
	ET	Exposure Time	hr/day	24	U.S. EPA 2009a	
	EF	Exposure Frequency	day/yr	350	U.S. EPA 1991a	
	ED-NC	Exposure Duration - Noncancer	yr	6	U.S. EPA 1991a	
	ED-C	Exposure Duration - Cancer	yr	6	U.S. EPA 1991a	
	BW	Body Weight	kg	15	U.S. EPA 1989	
	AT-NC	Averaging time - Noncancer	days	2,190	U.S. EPA 1989	
	AT-C	Averaging Time - Cancer	days	25,550	U.S. EPA 1989	
	CF <sub>2</sub>	Conversion Factor	hour/day	24	U.S. EPA 2009a	
NOTE: (1) Taken from Exhibit 3-5 of USEPA 2004. (2) Taken from Exhibit 3-4 of USEPA 2004.  BPJ = Best Professional Judgment U.S. EPA = United States Environmental Protection Agency CDI = chronic daily intake mg/kg = milligrams per kilogram kg/mg = kilograms per milligram mg/cm <sup>2</sup> = milligrams per square centimeter mg/day = milligrams per day day/yr = days per year RME = Reasonable Maximum Exposure mg/m <sup>3</sup> = milligram per cubic meter µg/m <sup>3</sup> = micrograms per cubic meter cm <sup>2</sup> /event = square centimeters per event µg/mg = microgram per milligram kg = kilogram hr/day = hours per day						

**TABLE 9**  
**VALUES USED FOR CONSTRUCTION WORKER DAILY SOIL INTAKE EQUATIONS**  
**AOC-4, FALCON REFINERY SUPERFUND SITE**  
**INGLESIDE, SAN PATRICIO COUNTY, TEXAS**

Scenario Timeframe: Current/Future  
Medium: Soil  
Exposure Medium: Soil, Air  
Exposure Point: AOC-4  
Receptor Population: Construction Worker  
Receptor Age: Adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/Reference	Intake Equation / Model Name
Ingestion	CS	Chemical Concentration in Soil	mg/kg	Chemical-Specific	Chemical-Specific	$CDI (mg/kg/day) = CS \times CR \times EF \times ED \times CF / (BW \times AT)$
	CR	Ingestion Rate	mg/day	330	U.S. EPA 1991a	
	EF	Exposure Frequency	day/yr	250	U.S. EPA 1991a	
	ED	Exposure Duration	yr	1	BPJ (1)	
	BW	Body Weight	kg	70	U.S. EPA 1989	
	AT-NC	Averaging time - Noncancer	days	365	U.S. EPA 1989	
	AT-C	Averaging Time - Cancer	days	25,550	U.S. EPA 1989	
	CF	Conversion Factor	kg/mg	1.0E-06	U.S. EPA 1989	
Dermal	CS	Chemical Concentration in Soil	mg/kg	Chemical-Specific	Chemical-Specific	$CDI (mg/kg/day) = CS \times SA \times AF \times ABS \times EF \times ED \times CF / (BW \times AT)$
	SA	Surface Area for Contact	cm <sup>2</sup> /event	3,300	U.S. EPA 2004 (2)	
	AF	Adherence Factor	mg/cm <sup>2</sup>	0.2	U.S. EPA 2004 (2)	
	EF	Exposure Frequency	event/yr	250	U.S. EPA 1991a	
	ED	Exposure Duration	yr	1	BPJ (1)	
	BW	Body Weight	kg	70	U.S. EPA 1989	
	AT-NC	Averaging time - Noncancer	days	365	U.S. EPA 1989	
	AT-C	Averaging Time - Cancer	days	25,550	U.S. EPA 1989	
	CF	Conversion Factor	kg/mg	1.0E-06	U.S. EPA 1989	
	ABS	Dermal Absorption Fraction	unitless	Chemical-Specific	U.S. EPA 2004 (3)	
Inhalation	CA	Chemical Concentration in Air	mg/m <sup>3</sup>	Chemical-Specific	Chemical-Specific	$Exposure\ Concentration (\mu g/m^3\ or\ mg/m^3) = CA \times CF_1 \times ET \times EF \times ED / AT \times CF_2$ Note: CF <sub>1</sub> only used in carcinogenic intake calculations
	CF <sub>1</sub>	Conversion Factor	μg/mg	1,000	U.S. EPA 2009a	
	ET	Exposure Time	hr/day	8	U.S. EPA 2009a	
	EF	Exposure Frequency	day/yr	250	U.S. EPA 1991a	
	ED	Exposure Duration	yr	1	BPJ (1)	
	BW	Body Weight	kg	70	U.S. EPA 1989	
	AT-NC	Averaging time - Noncancer	days	365	U.S. EPA 1989	
	AT-C	Averaging Time - Cancer	days	25,550	U.S. EPA 1989	
	CF <sub>2</sub>	Conversion Factor	hour/day	24	U.S. EPA 2009a	

**NOTE:**

- (1) Construction events are assumed to extend for up to one year total in duration.  
(2) Taken from Exhibit 3-5 of USEPA 2004.  
(3) Taken from Exhibit 3-4 of USEPA 2004.

BPJ = Best Professional Judgment

U.S. EPA = United States Environmental Protection Agency

CDI = chronic daily intake

mg/kg = milligrams per kilogram

kg/mg = kilograms per milligram

mg/cm<sup>2</sup> = milligrams per square centimeter

mg/day = milligrams per day

day/yr = days per year

RME = Reasonable Maximum Exposure

mg/m<sup>3</sup> = milligram per cubic meter

μg/m<sup>3</sup> = micrograms per cubic meter

cm<sup>2</sup>/event = square centimeters per event

μg/mg = microgram per milligram

kg = kilogram

hr/day = hours per day

**TABLE 10**  
**NON-CANCER TOXICITY DATA - ORAL/DERMAL**  
**AOC-4, FALCON REFINERY SUPERFUND SITE**  
**INGLESIDE, SAN PATRICIO COUNTY, TEXAS**

Constituents of Potential Concern	Chronic/ Subchronic	Oral RfD Value (mg/kg-day)	Oral to Dermal Adjustment Factor (GI ABS) <sup>(1)</sup>	Adjusted Dermal RfD <sup>(2)</sup> (mg/kg bw-day)	Primary Target Organ	Combined Uncertainty/ Modifying Factors	Sources of RfD: Target Organ	Dates of RfD: Target Organ <sup>(3)</sup> (mm/dd/yy)
<b>Inorganics</b>								
ALUMINUM	Chronic	1.0E+00	1	1.0E+00	Central Nervous System	100/1	PPRTV	10/23/2006
ARSENIC	Chronic	3.0E-04	1	3.0E-04	Skin	3/1	IRIS	3/10/2014
COBALT	Chronic	3.0E-04	1	3.0E-04	Thyroid	3000/1	PPTRV	8/25/2008
IRON	Chronic	7.0E-01	1	7.0E-01	Gastrointestinal System	1.5/1	PPRTV	9/11/2006
MANGANESE	Chronic	4.7E-02	0.04	1.9E-03	Central Nervous System	1/3	IRIS	3/10/2014
MERCURY	Chronic	1.0E-04	1	1.0E-04	Central Nervous System	10/1	IRIS	3/10/2014
SELENIUM	Chronic	5.0E-03	1	5.0E-03	Hair and Skin	3/1	IRIS	3/10/2014
<b>PAHs</b>								
BENZ(A)ANTHRACENE	NA	NA	1	NA	NA	NA/NA	IRIS	3/10/2014
BENZO(B)FLUORANTHENE	NA	NA	1	NA	NA	NA/NA	IRIS	3/10/2014
BENZO(A)PYRENE	NA	NA	1	NA	NA	NA/NA	IRIS	3/10/2014
DIBENZ(A,H)ANTHRACENE	NA	NA	1	NA	NA	NA/NA	IRIS	3/10/2014
INDENO(1,2,3-C,D)PYRENE	NA	NA	1	NA	NA	NA/NA	IRIS	3/10/2014
<p>NOTE:</p> <p>NA = Not Available</p> <p>RfD = Reference Dose</p> <p>mg/kg-day = milligram per kilogram-day</p> <p>GI ABS = Gastrointestinal Absorption Fraction</p> <p>(1) Taken from USEPA 2004 Guidance.</p> <p>(2) Dermal toxicological values adjusted from oral values using USEPA 2004 recommended chemical-specific gastrointestinal absorption factors (GI ABS). RfDs are multiplied by the GI ABS.</p> <p>(3) IRIS - Integrated Risk Information System. For IRIS values, the date IRIS was searched is provided. Available at: <a href="http://www.epa.gov/iris/">http://www.epa.gov/iris/</a></p> <p>PPRTV - Provisional Peer-Reviewed Toxicity Value. For PPRTV values, the date of the issue paper is provided. Available at: <a href="http://hhpprtv.ornl.gov/">http://hhpprtv.ornl.gov/</a></p>								

**TABLE 11**  
**NON-CANCER TOXICITY DATA - INHALATION**  
**AOC-4, FALCON REFINERY SUPERFUND SITE**  
**INGLESIDE, SAN PATRICIO COUNTY, TEXAS**

Constituents of Potential Concern	Chronic/ Subchronic	Value Inhalation (RfC) (mg/m <sup>3</sup> )	Primary Target Organ	Combined Uncertainty/Modifying Factors	Sources of RfC Target Organ	Dates <sup>(1)</sup> (mm/dd/yy)
<b>Inorganics</b>						
ALUMINUM	Chronic	5.0E-03	Respiratory System	300/1	PPRTV	10/23/2006
ARSENIC	Chronic	1.5E-05	Cardiovascular System	30/1	CalEPA	3/10/2014
COBALT	Chronic	6.0E-06	Respiratory System	300/1	PPRTV	8/25/2008
IRON	NA	NA	NA	NA	PPRTV	9/11/2006
MANGANESE	Chronic	5.0E-05	Central Nervous System	1000/1	IRIS	3/10/2014
MERCURY	Chronic	3.00E-04	Central Nervous System	30/1	IRIS	3/10/2014
SELENIUM	Chronic	2.00E-02	None	NA	IRIS	3/10/2014
<b>PAHs</b>						
BENZ(A)ANTHRACENE	NA	NA	NA	NA	IRIS	3/10/2014
BENZO(B)FLUORANTHENE	NA	NA	NA	NA	IRIS	3/10/2014
BENZO(A)PYRENE	NA	NA	NA	NA	IRIS	3/10/2014
DIBENZ(A,H)ANTHRACENE	NA	NA	NA	NA	IRIS	3/10/2014
INDENO(1,2,3-C,D)PYRENE	NA	NA	NA	NA	IRIS	3/10/2014
NOTE: NA = Not Available RfC = Reference Concentration mg/m <sup>3</sup> = milligrams per cubic meter (1) IRIS - Integrated Risk Information System. For IRIS values, the date IRIS was searched is provided. Available at: <a href="http://www.epa.gov/iris/">http://www.epa.gov/iris/</a> PPRTV - Provisional Peer-Reviewed Toxicity Value. For PPRTV values, the date of the issue paper is provided. Available at: <a href="http://hhpprtv.ornl.gov/">http://hhpprtv.ornl.gov/</a> CalEPA - California Environmental Protection Agency. For CalEPA values, the date searched is provided.						

**TABLE 12**  
**CHEMICAL-SPECIFIC PARAMETERS**  
**AOC-4, FALCON REFINERY SUPERFUND SITE**  
**INGLESIDE, SAN PATRICIO COUNTY, TEXAS**

Constituents of Potential Concern	Absorption Factor	Reference	GI ABS	Reference
<b>Inorganics</b>				
ALUMINUM	NA	U.S. EPA, 2004	1	U.S. EPA, 2004
ARSENIC	0.03	U.S. EPA, 2004	1	U.S. EPA, 2004
COBALT	NA	U.S. EPA, 2004	1	U.S. EPA, 2004
IRON	NA	U.S. EPA, 2004	1	U.S. EPA, 2004
MANGANESE	NA	U.S. EPA, 2004	0.04	U.S. EPA, 2004
MERCURY	NA	U.S. EPA, 2004	1	U.S. EPA, 2004
SELENIUM	NA	U.S. EPA, 2004	1	U.S. EPA, 2004
<b>PAHs</b>				
BENZ(A)ANTHRACENE	0.13	U.S. EPA, 2004	1	U.S. EPA, 2004
BENZO(B)FLUORANTHENE	0.13	U.S. EPA, 2004	1	U.S. EPA, 2004
BENZO(A)PYRENE	0.13	U.S. EPA, 2004	1	U.S. EPA, 2004
DIBENZ(A,H)ANTHRACENE	0.13	U.S. EPA, 2004	1	U.S. EPA, 2004
INDENO(1,2,3-C,D)PYRENE	0.13	U.S. EPA, 2004	1	U.S. EPA, 2004
NOTE: NA = Data not available. GI ABS = Gastrointestinal Absorption Fraction U.S. EPA, 2004 = U.S. Environmental Protection Agency, 2004. <i>Risk Assessment Guidance for Superfund. Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment).</i> Final Guidance.				

**TABLE 13**  
**CANCER TOXICITY DATA - ORAL/DERMAL**  
**AOC-4, FALCON REFINERY SUPERFUND SITE**  
**INGLESIDE, SAN PATRICIO COUNTY, TEXAS**

Constituents of Potential Concern	Oral Cancer Slope Factor	Oral to Dermal Adjustment Factor (GI ABS) <sup>(1)</sup>	Absorbed Cancer Slope Factor for Dermal <sup>(2)</sup>	Units	Weight of Evidence/Cancer Guideline Description	Mutagenic Compound	Source	Date <sup>(3)</sup> (mm/dd/yy)
<b>Inorganics</b>								
ALUMINUM	NA	1	NA	per (mg/kg-day)	D		PPRTV	10/23/2006
ARSENIC	1.5E+00	1	1.5E+00	per (mg/kg-day)	A		IRIS	3/10/2014
COBALT	NA	1	NA	per (mg/kg-day)	NA		PPTRV	8/25/2008
IRON	NA	1	NA	per (mg/kg-day)	NA		PPRTV	9/11/2006
MANGANESE	NA	0.04	NA	per (mg/kg-day)	D		IRIS	3/10/2014
MERCURY	NA	1	NA	per (mg/kg-day)	D		IRIS	3/10/2014
SELENIUM	NA	1	NA	per (mg/kg-day)	D		IRIS	3/10/2014
<b>PAHs</b>								
BENZ(A)ANTHRACENE	7.30E-01	1	7.30E-01	per (mg/kg-day)	B2	M	IRIS	3/10/2014
BENZO(B)FLUORANTHEN	7.30E-01	1	7.30E-01	per (mg/kg-day)	B2	M	IRIS	3/10/2014
BENZO(A)PYRENE	7.30E+00	1	7.30E+00	per (mg/kg-day)	B2	M	IRIS	3/10/2014
DIBENZ(A,H)ANTHRACEN	7.30E+00	1	7.30E+00	per (mg/kg-day)	B2	M	IRIS	3/10/2014
INDENO(1,2,3-C,D)PYRENI	7.30E-01	1	7.30E-01	per (mg/kg-day)	B2	M	IRIS	3/10/2014
<p>NOTE:</p> <p>NA = Not Available</p> <p>mg/kg-day = milligram per kilogram-day</p> <p>GI ABS = Gastrointestinal Absorption Fraction</p> <p>(1) Taken from USEPA 2004 Guidance.</p> <p>(2) Dermal Toxicological values adjusted from oral values using USEPA 2004 recommended chemical-specific gastrointestinal absorption factors (GI ABS). Cancer slope factors are divided by the GI ABS.</p> <p>(3) IRIS - Integrated Risk Information System. For IRIS values, the date IRIS was searched is provided. Available at: <a href="http://www.epa.gov/iris/">http://www.epa.gov/iris/</a></p> <p>PPRTV - Provisional Peer-Reviewed Toxicity Value, the date of the issue paper is provided. Available at: <a href="http://hhpprtv.ornl.gov/">http://hhpprtv.ornl.gov/</a></p> <p>Weight of Evidence: A - Human carcinogen  B1 - Probable human carcinogen - indicate that limited human data are available  B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans  C - Possible human carcinogen  D - Not classifiable as a human carcinogen  E - Evidence of noncarcinogenicity</p>								

**TABLE 14**  
**CANCER TOXICITY DATA - INHALATION**  
**AOC-4, FALCON REFINERY SUPERFUND SITE**  
**INGLESIDE, SAN PATRICIO COUNTY, TEXAS**

Constituents of Potential Concern	Unit Risk		Weight of Evidence/Cancer Guideline Description	Mutagenic	Unit Risk	
	Value	Units			Source	Date <sup>(1)</sup>
Inorganics						
ALUMINUM	NA	per (ug/m <sup>3</sup> )	D		PPRTV	10/23/2006
ARSENIC	4.3E-03	per (ug/m <sup>3</sup> )	A		IRIS	3/10/2014
COBALT	9.0E-03	per (ug/m <sup>3</sup> )	B2		PPTRV	8/25/2008
IRON	NA	per (ug/m <sup>3</sup> )	NA		PPRTV	9/11/2006
MANGANESE	NA	per (ug/m <sup>3</sup> )	D		IRIS	3/10/2014
MERCURY	NA	per (ug/m <sup>3</sup> )	D		IRIS	3/10/2014
SELENIUM	NA	per (ug/m <sup>3</sup> )	D		IRIS	3/10/2014
PAHs						
BENZ(A)ANTHRACENE	1.10E-04	per (ug/m <sup>3</sup> )	B2	M	CalEPA	5/1/2009
BENZO(B)FLUORANTHENE	1.10E-04	per (ug/m <sup>3</sup> )	B2	M	CalEPA	5/1/2009
BENZO(A)PYRENE	1.10E-03	per (ug/m <sup>3</sup> )	B2	M	CalEPA	5/1/2009
DIBENZ(A,H)ANTHRACENE	1.10E-03	per (ug/m <sup>3</sup> )	B2	M	CalEPA	5/1/2009
INDENO(1,2,3-C,D)PYRENE	1.10E-04	per (ug/m <sup>3</sup> )	B2	M	CalEPA	5/1/2009
NOTE:						
NA = Not Available				Weight of Evidence: A - Human carcinogen		
(1) IRIS - Integrated Risk Information System. For IRIS values, the date IRIS was searched is provided.				B1 - Probable human carcinogen -		
Available at: <a href="http://www.epa.gov/iris/">http://www.epa.gov/iris/</a>				indicate that limited human data are available		
PPRTV - Provisional Peer-Reviewed Toxicity Value, the date of the issue paper is provided. Available				B2 - Probable human carcinogen -		
at: <a href="http://hhpprtv.ornl.gov/">http://hhpprtv.ornl.gov/</a>				indicates sufficient evidence in animals		
CalEPA - California Environmental Protection Agency, Cancer Potency Factors				and inadequate or no evidence in humans		
				C - Possible human carcinogen		
				D - Not classifiable as a human carcinogen		
				E - Evidence of noncarcinogenicity		

TABLE 15  
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS  
REASONABLE MAXIMUM EXPOSURE  
AOC-4, FALCON REFINERY SUPERFUND SITE  
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

Scenario Timeframe: Future  
Receptor Population: Resident  
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations						Non-Cancer Hazard Calculations					
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient		
							Value	Units	Value	Units		Value	Units	Value	Units			
Soil	Surface Soil	AOC-4	Ingestion	Inorganics	1.56E+04	(mg/kg)	7.33E-03	(mg/kg-day)	NA	per (mg/kg-day)	--	2.14E-02	(mg/kg-day)	1.00E+00	(mg/kg-day)	2.1E-02		
				ALUMINUM	4.27E+00	(mg/kg)	2.01E-06	(mg/kg-day)	1.50E+00	per (mg/kg-day)	3.0E-06	5.85E-06	(mg/kg-day)	3.00E-04	(mg/kg-day)	1.9E-02		
				ARSENIC	2.95E+00	(mg/kg)	1.39E-06	(mg/kg-day)	NA	per (mg/kg-day)	--	4.04E-06	(mg/kg-day)	3.00E-04	(mg/kg-day)	1.3E-02		
				COBALT	8.95E+03	(mg/kg)	4.20E-03	(mg/kg-day)	NA	per (mg/kg-day)	--	1.23E-02	(mg/kg-day)	7.00E-01	(mg/kg-day)	1.8E-02		
				IRON	1.85E+02	(mg/kg)	8.69E-05	(mg/kg-day)	NA	per (mg/kg-day)	--	2.53E-04	(mg/kg-day)	4.70E-02	(mg/kg-day)	5.4E-03		
				MANGANESE	1.18E+00	(mg/kg)	5.54E-07	(mg/kg-day)	NA	per (mg/kg-day)	--	1.62E-06	(mg/kg-day)	1.00E-04	(mg/kg-day)	1.6E-02		
				MERCURY	PAHs	5.90E-01	(mg/kg)	4.99E-07	(mg/kg-day)	7.30E-01	per (mg/kg-day)	3.6E-07	8.08E-07	(mg/kg-day)	NA	(mg/kg-day)	--	
				BENZ(A)ANTHRACENE	8.20E-01	(mg/kg)	6.93E-07	(mg/kg-day)	7.30E-01	per (mg/kg-day)	5.1E-07	1.12E-06	(mg/kg-day)	NA	(mg/kg-day)	--		
				BENZO(B)FLUORANTHENE	3.87E-01	(mg/kg)	3.27E-07	(mg/kg-day)	7.30E+00	per (mg/kg-day)	2.4E-06	5.30E-07	(mg/kg-day)	NA	(mg/kg-day)	--		
				BENZO(A)PYRENE	6.98E-02	(mg/kg)	5.90E-08	(mg/kg-day)	7.30E+00	per (mg/kg-day)	4.3E-07	9.56E-08	(mg/kg-day)	NA	(mg/kg-day)	--		
				DIBENZ(A,H)ANTHRACENE	2.92E-01	(mg/kg)	2.47E-07	(mg/kg-day)	7.30E-01	per (mg/kg-day)	1.8E-07	4.00E-07	(mg/kg-day)	NA	(mg/kg-day)	--		
				INDENO(1,2,3-C,D)PYRENE	Exp. Route Total						6.9E-06					9.3E-02		
				Dermal	Inorganics	1.56E+04	(mg/kg)	NA	(mg/kg-day)	NA	per (mg/kg-day)	--	NA	(mg/kg-day)	1.00E+00	(mg/kg-day)	--	
					ALUMINUM	4.27E+00	(mg/kg)	2.40E-07	(mg/kg-day)	1.50E+00	per (mg/kg-day)	3.6E-07	7.00E-07	(mg/kg-day)	3.00E-04	(mg/kg-day)	2.3E-03	
			ARSENIC		2.95E+00	(mg/kg)	NA	(mg/kg-day)	NA	per (mg/kg-day)	--	NA	(mg/kg-day)	3.00E-04	(mg/kg-day)	--		
			COBALT		8.95E+03	(mg/kg)	NA	(mg/kg-day)	NA	per (mg/kg-day)	--	NA	(mg/kg-day)	7.00E-01	(mg/kg-day)	--		
			IRON		1.85E+02	(mg/kg)	NA	(mg/kg-day)	NA	per (mg/kg-day)	--	NA	(mg/kg-day)	1.88E-03	(mg/kg-day)	--		
			MANGANESE		1.18E+00	(mg/kg)	NA	(mg/kg-day)	NA	per (mg/kg-day)	--	NA	(mg/kg-day)	1.00E-04	(mg/kg-day)	--		
			MERCURY		PAHs	5.90E-01	(mg/kg)	2.59E-07	(mg/kg-day)	7.30E-01	per (mg/kg-day)	1.9E-07	4.19E-07	(mg/kg-day)	NA	(mg/kg-day)	--	
			BENZ(A)ANTHRACENE		8.20E-01	(mg/kg)	3.60E-07	(mg/kg-day)	7.30E-01	per (mg/kg-day)	2.6E-07	5.83E-07	(mg/kg-day)	NA	(mg/kg-day)	--		
			BENZO(B)FLUORANTHENE		3.87E-01	(mg/kg)	1.70E-07	(mg/kg-day)	7.30E+00	per (mg/kg-day)	1.2E-06	2.75E-07	(mg/kg-day)	NA	(mg/kg-day)	--		
			BENZO(A)PYRENE		6.98E-02	(mg/kg)	3.06E-08	(mg/kg-day)	7.30E+00	per (mg/kg-day)	2.2E-07	4.96E-08	(mg/kg-day)	NA	(mg/kg-day)	--		
			DIBENZ(A,H)ANTHRACENE		2.92E-01	(mg/kg)	1.28E-07	(mg/kg-day)	7.30E-01	per (mg/kg-day)	9.3E-08	2.07E-07	(mg/kg-day)	NA	(mg/kg-day)	--		
			INDENO(1,2,3-C,D)PYRENE		Exp. Route Total						2.4E-06					2.3E-03		
			Exposure Point Total							9.2E-06					9.6E-02			
			Exposure Medium Total							9.2E-06					9.6E-02			
			Air	AOC-4	Inhalation	Inorganics	5.59E-05	(mg/m³)	1.84E-02	(ug/m³)	NA	per (ug/m³)	--	5.36E-05	(mg/m³)	5.00E-03	(mg/m³)	1.1E-02
						ALU/MINUM	1.53E-08	(mg/m³)	5.03E-06	(ug/m³)	4.30E-03	per (ug/m³)	2.2E-08	1.47E-08	(mg/m³)	1.50E-05	(mg/m³)	9.8E-04
						ARSENIC	1.06E-08	(mg/m³)	3.48E-06	(ug/m³)	9.00E-03	per (ug/m³)	3.1E-08	1.01E-08	(mg/m³)	6.00E-06	(mg/m³)	1.7E-03
	COBALT					3.21E-05	(mg/m³)	1.05E-02	(ug/m³)	NA	per (ug/m³)	--	3.08E-05	(mg/m³)	NA	(mg/m³)	--	
IRON	6.63E-07	(mg/m³)				2.18E-04	(ug/m³)	NA	per (ug/m³)	--	6.36E-07	(mg/m³)	5.00E-05	(mg/m³)	1.3E-02			
MANGANESE	4.23E-09	(mg/m³)				1.39E-06	(ug/m³)	NA	per (ug/m³)	--	4.06E-09	(mg/m³)	3.00E-04	(mg/m³)	1.4E-05			
MERCURY	PAHs	2.11E-09				(mg/m³)	1.25E-06	(ug/m³)	1.10E-04	per (ug/m³)	1.4E-10	2.03E-09	(mg/m³)	NA	(mg/m³)	--		
BENZ(A)ANTHRACENE	2.94E-09	(mg/m³)				1.74E-06	(ug/m³)	1.10E-04	per (ug/m³)	1.9E-10	2.82E-09	(mg/m³)	NA	(mg/m³)	--			
BENZO(B)FLUORANTHENE	1.39E-09	(mg/m³)				8.21E-07	(ug/m³)	1.10E-03	per (ug/m³)	9.0E-10	1.33E-09	(mg/m³)	NA	(mg/m³)	--			
BENZO(A)PYRENE	2.50E-10	(mg/m³)				1.48E-07	(ug/m³)	1.10E-03	per (ug/m³)	1.6E-10	2.40E-10	(mg/m³)	NA	(mg/m³)	--			
DIBENZ(A,H)ANTHRACENE	1.05E-09	(mg/m³)				6.19E-07	(ug/m³)	1.10E-04	per (ug/m³)	6.8E-11	1.00E-09	(mg/m³)	NA	(mg/m³)	--			
INDENO(1,2,3-C,D)PYRENE	Exp. Route Total									5.4E-08					2.6E-02			
Exposure Point Total										5.4E-08					2.6E-02			
Exposure Medium Total										5.4E-08					2.6E-02			
Soil Total									9.3E-06					1.2E-01				
Total of Receptor Risks Across All Media											9.3E-06	Total of Receptor Hazards Across All Media					1.2E-01	

NOTE:  
1) Dermal intake is "NA" due to no published dermal absorption factor. Please see Table 12 and EPA 2004 guidance.  
CSF = Cancer Slope Factor  
EPC = Exposure Point Concentration  
PAH = Polycyclic Aromatic Hydrocarbon  
RfD = Reference Dose  
RfC = Reference Concentration

TABLE 16  
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS  
REASONABLE MAXIMUM EXPOSURE  
AOC-4, FALCON REFINERY SUPERFUND SITE  
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

Scenario Timeframe: Future  
Receptor Population: Resident  
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations						
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient		
							Value	Units	Value	Units		Value	Units	Value	Units			
Soil	Surface Soil	AOC-4	Ingestion	Inorganics	1.56E+04	(mg/kg)	1.71E-02	(mg/kg-day)	NA	per (mg/kg-day)	--	1.99E-01	(mg/kg-day)	1.00E+00	(mg/kg-day)	2.0E-01		
				ALUMINUM	4.27E+00	(mg/kg)	4.68E-06	(mg/kg-day)	1.50E+00	per (mg/kg-day)	7.0E-06	5.46E-05	(mg/kg-day)	3.00E-04	(mg/kg-day)	1.8E-01		
				ARSENIC	2.95E+00	(mg/kg)	3.23E-06	(mg/kg-day)	NA	per (mg/kg-day)	--	3.77E-05	(mg/kg-day)	3.00E-04	(mg/kg-day)	1.3E-01		
				COBALT	8.95E+03	(mg/kg)	9.81E-03	(mg/kg-day)	NA	per (mg/kg-day)	--	1.14E-01	(mg/kg-day)	7.00E-01	(mg/kg-day)	1.6E-01		
				IRON	1.85E+02	(mg/kg)	2.03E-04	(mg/kg-day)	NA	per (mg/kg-day)	--	2.37E-03	(mg/kg-day)	4.70E-02	(mg/kg-day)	5.0E-02		
				MANGANESE	1.18E+00	(mg/kg)	1.29E-06	(mg/kg-day)	NA	per (mg/kg-day)	--	1.51E-05	(mg/kg-day)	1.00E-04	(mg/kg-day)	1.5E-01		
				MERCURY	PAHs	5.90E-01	(mg/kg)	3.43E-06	(mg/kg-day)	7.30E-01	per (mg/kg-day)	2.5E-06	7.54E-06	(mg/kg-day)	NA	(mg/kg-day)	--	
				BENZ(A)ANTHRACENE	8.20E-01	(mg/kg)	4.76E-06	(mg/kg-day)	7.30E-01	per (mg/kg-day)	3.5E-06	1.05E-05	(mg/kg-day)	NA	(mg/kg-day)	--		
				BENZO(B)FLUORANTHENE	3.87E-01	(mg/kg)	2.25E-06	(mg/kg-day)	7.30E+00	per (mg/kg-day)	1.6E-05	4.95E-06	(mg/kg-day)	NA	(mg/kg-day)	--		
				BENZO(A)PYRENE	6.98E-02	(mg/kg)	4.05E-07	(mg/kg-day)	7.30E+00	per (mg/kg-day)	3.0E-06	8.92E-07	(mg/kg-day)	NA	(mg/kg-day)	--		
				DIBENZ(A,H)ANTHRACENE	2.92E-01	(mg/kg)	1.70E-06	(mg/kg-day)	7.30E-01	per (mg/kg-day)	1.2E-06	3.73E-06	(mg/kg-day)	NA	(mg/kg-day)	--		
				INDENO(1,2,3-C,D)PYRENE	Exp. Route Total							3.4E-05					8.7E-01	
				Dermal <sup>1</sup>	Inorganics	1.56E+04	(mg/kg)	NA	(mg/kg-day)	NA	per (mg/kg-day)	--	NA	(mg/kg-day)	1.00E+00	(mg/kg-day)	--	
					ALUMINUM	4.27E+00	(mg/kg)	3.93E-07	(mg/kg-day)	1.50E+00	per (mg/kg-day)	5.9E-07	4.59E-06	(mg/kg-day)	3.00E-04	(mg/kg-day)	1.5E-02	
			ARSENIC		2.95E+00	(mg/kg)	NA	(mg/kg-day)	NA	per (mg/kg-day)	--	NA	(mg/kg-day)	3.00E-04	(mg/kg-day)	--		
			COBALT		8.95E+03	(mg/kg)	NA	(mg/kg-day)	NA	per (mg/kg-day)	--	NA	(mg/kg-day)	7.00E-01	(mg/kg-day)	--		
			IRON		1.85E+02	(mg/kg)	NA	(mg/kg-day)	NA	per (mg/kg-day)	--	NA	(mg/kg-day)	1.88E-03	(mg/kg-day)	--		
			MANGANESE		1.18E+00	(mg/kg)	NA	(mg/kg-day)	NA	per (mg/kg-day)	--	NA	(mg/kg-day)	1.00E-04	(mg/kg-day)	--		
			MERCURY		PAHs	5.90E-01	(mg/kg)	1.25E-06	(mg/kg-day)	7.30E-01	per (mg/kg-day)	9.1E-07	2.75E-06	(mg/kg-day)	NA	(mg/kg-day)	--	
			BENZ(A)ANTHRACENE		8.20E-01	(mg/kg)	1.73E-06	(mg/kg-day)	7.30E-01	per (mg/kg-day)	1.3E-06	3.82E-06	(mg/kg-day)	NA	(mg/kg-day)	--		
			BENZO(B)FLUORANTHENE		3.87E-01	(mg/kg)	8.18E-07	(mg/kg-day)	7.30E+00	per (mg/kg-day)	6.0E-06	1.80E-06	(mg/kg-day)	NA	(mg/kg-day)	--		
			BENZO(A)PYRENE		6.98E-02	(mg/kg)	1.48E-07	(mg/kg-day)	7.30E+00	per (mg/kg-day)	1.1E-06	3.25E-07	(mg/kg-day)	NA	(mg/kg-day)	--		
			DIBENZ(A,H)ANTHRACENE		2.92E-01	(mg/kg)	6.17E-07	(mg/kg-day)	7.30E-01	per (mg/kg-day)	4.5E-07	1.36E-06	(mg/kg-day)	NA	(mg/kg-day)	--		
			INDENO(1,2,3-C,D)PYRENE		Exp. Route Total							1.0E-05					1.5E-02	
			Exposure Point Total								4.4E-05					8.9E-01		
			Exposure Medium Total								4.4E-05					8.9E-01		
			Air	AOC-4	Inhalation	Inorganics	5.59E-05	(mg/m <sup>3</sup> )	4.60E-03	(ug/m <sup>3</sup> )	NA	per (ug/m <sup>3</sup> )	--	5.36E-05	(mg/m <sup>3</sup> )	5.00E-03	(mg/m <sup>3</sup> )	1.1E-02
						ALUMINUM	1.53E-08	(mg/m <sup>3</sup> )	1.26E-06	(ug/m <sup>3</sup> )	4.30E-03	per (ug/m <sup>3</sup> )	5.4E-09	1.47E-08	(mg/m <sup>3</sup> )	1.50E-05	(mg/m <sup>3</sup> )	9.8E-04
						ARSENIC	1.06E-08	(mg/m <sup>3</sup> )	8.69E-07	(ug/m <sup>3</sup> )	9.00E-03	per (ug/m <sup>3</sup> )	7.8E-09	1.01E-08	(mg/m <sup>3</sup> )	6.00E-06	(mg/m <sup>3</sup> )	1.7E-03
						COBALT	3.21E-05	(mg/m <sup>3</sup> )	2.64E-03	(ug/m <sup>3</sup> )	NA	per (ug/m <sup>3</sup> )	--	3.08E-05	(mg/m <sup>3</sup> )	NA	(mg/m <sup>3</sup> )	--
IRON	6.63E-07	(mg/m <sup>3</sup> )				5.45E-05	(ug/m <sup>3</sup> )	NA	per (ug/m <sup>3</sup> )	--	6.36E-07	(mg/m <sup>3</sup> )	5.00E-05	(mg/m <sup>3</sup> )	1.3E-02			
MANGANESE	4.23E-09	(mg/m <sup>3</sup> )				3.48E-07	(ug/m <sup>3</sup> )	NA	per (ug/m <sup>3</sup> )	--	4.06E-09	(mg/m <sup>3</sup> )	3.00E-04	(mg/m <sup>3</sup> )	1.4E-05			
MERCURY	PAHs	2.11E-09				(mg/m <sup>3</sup> )	9.21E-07	(ug/m <sup>3</sup> )	1.10E-04	per (ug/m <sup>3</sup> )	1.0E-10	2.03E-09	(mg/m <sup>3</sup> )	NA	(mg/m <sup>3</sup> )	--		
BENZ(A)ANTHRACENE	2.94E-09	(mg/m <sup>3</sup> )				1.28E-06	(ug/m <sup>3</sup> )	1.10E-04	per (ug/m <sup>3</sup> )	1.4E-10	2.82E-09	(mg/m <sup>3</sup> )	NA	(mg/m <sup>3</sup> )	--			
BENZO(B)FLUORANTHENE	1.39E-09	(mg/m <sup>3</sup> )				6.04E-07	(ug/m <sup>3</sup> )	1.10E-03	per (ug/m <sup>3</sup> )	6.6E-10	1.33E-09	(mg/m <sup>3</sup> )	NA	(mg/m <sup>3</sup> )	--			
BENZO(A)PYRENE	2.50E-10	(mg/m <sup>3</sup> )				1.09E-07	(ug/m <sup>3</sup> )	1.10E-03	per (ug/m <sup>3</sup> )	1.2E-10	2.40E-10	(mg/m <sup>3</sup> )	NA	(mg/m <sup>3</sup> )	--			
DIBENZ(A,H)ANTHRACENE	1.05E-09	(mg/m <sup>3</sup> )				4.56E-07	(ug/m <sup>3</sup> )	1.10E-04	per (ug/m <sup>3</sup> )	5.0E-11	1.00E-09	(mg/m <sup>3</sup> )	NA	(mg/m <sup>3</sup> )	--			
INDENO(1,2,3-C,D)PYRENE	Exp. Route Total										1.4E-08					2.6E-02		
Exposure Point Total											1.4E-08					2.6E-02		
Exposure Medium Total											1.4E-08					2.6E-02		
Soil Total											4.4E-05					9.1E-01		
Total of Receptor Risks Across All Media											4.4E-05	Total of Receptor Hazards Across All Media					9.1E-01	

NOTE:

1) Dermal intake is "NA" due to no published dermal absorption factor. Please see Table 12 and EPA 2004 guidance.

CSF = Cancer Slope Factor

EPC = Exposure Point Concentration

PAH = Polycyclic Aromatic Hydrocarbon

RfD = Reference Dose

RfC = Reference Concentration

TABLE 17  
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS  
REASONABLE MAXIMUM EXPOSURE  
AOC-4, FALCON REFINERY SUPERFUND SITE  
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

Scenario Timeframe: Current/Future  
Receptor Population: Construction Worker  
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Constituent of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations					
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient	
							Value	Units	Value	Units		Value	Units	Value	Units		
Soil	Surface Soil	AOC-4	Ingestion	Inorganics													
				ALUMINUM	1.56E+04	(mg/kg)	7.20E-04	(mg/kg-day)	NA	per (mg/kg-day)	--	5.04E-02	(mg/kg-day)	1.0E+00	(mg/kg-day)	5.0E-02	
				ARSENIC	4.27E+00	(mg/kg)	1.97E-07	(mg/kg-day)	1.5E+00	per (mg/kg-day)	3.0E-07	1.38E-05	(mg/kg-day)	3.0E-04	(mg/kg-day)	4.6E-02	
				COBALT	2.95E+00	(mg/kg)	1.36E-07	(mg/kg-day)	NA	per (mg/kg-day)	--	9.53E-06	(mg/kg-day)	3.0E-04	(mg/kg-day)	3.2E-02	
				MANGANESE	1.85E+02	(mg/kg)	8.53E-06	(mg/kg-day)	NA	per (mg/kg-day)	--	5.97E-04	(mg/kg-day)	4.7E-02	(mg/kg-day)	1.3E-02	
				MERCURY	1.18E+00	(mg/kg)	5.44E-08	(mg/kg-day)	NA	per (mg/kg-day)	--	3.81E-06	(mg/kg-day)	1.00E-04	(mg/kg-day)	3.81E-02	
				PAHs													
				BENZ(A)ANTHRACENE	5.90E-01	(mg/kg)	2.72E-08	(mg/kg-day)	7.3E-01	per (mg/kg-day)	2.0E-08	1.91E-06	(mg/kg-day)	NA	(mg/kg-day)	--	
				BENZO(B)FLUORANTHENE	8.20E-01	(mg/kg)	3.78E-08	(mg/kg-day)	7.3E-01	per (mg/kg-day)	2.8E-08	2.65E-06	(mg/kg-day)	NA	(mg/kg-day)	--	
				BENZO(A)PYRENE	3.87E-01	(mg/kg)	1.79E-08	(mg/kg-day)	7.3E+00	per (mg/kg-day)	1.3E-07	1.25E-06	(mg/kg-day)	NA	(mg/kg-day)	--	
				DIBENZ(A,H)ANTHRACENE	6.98E-02	(mg/kg)	3.22E-09	(mg/kg-day)	7.3E+00	per (mg/kg-day)	2.4E-08	2.25E-07	(mg/kg-day)	NA	(mg/kg-day)	--	
				INDENO(1,2,3-C,D)PYRENE	2.92E-01	(mg/kg)	1.35E-08	(mg/kg-day)	7.3E-01	per (mg/kg-day)	9.8E-09	9.43E-07	(mg/kg-day)	NA	(mg/kg-day)	--	
				Exp. Route Total									5.1E-07				
			Dermal <sup>1</sup>	Inorganics													
				ALUMINUM	1.56E+04	(mg/kg)	NA	(mg/kg-day)	NA	per (mg/kg-day)	--	NA	(mg/kg-day)	1E+00	(mg/kg-day)	--	
				ARSENIC	4.27E+00	(mg/kg)	1.18E-08	(mg/kg-day)	1.5E+00	per (mg/kg-day)	1.8E-08	8.27E-07	(mg/kg-day)	3E-04	(mg/kg-day)	2.8E-03	
				COBALT	2.95E+00	(mg/kg)	NA	(mg/kg-day)	NA	per (mg/kg-day)	--	NA	(mg/kg-day)	3E-04	(mg/kg-day)	--	
				MANGANESE	1.85E+02	(mg/kg)	NA	(mg/kg-day)	NA	per (mg/kg-day)	--	NA	(mg/kg-day)	2E-03	(mg/kg-day)	--	
				MERCURY	1.18E+00	(mg/kg)	NA	(mg/kg-day)	NA	per (mg/kg-day)	--	NA	(mg/kg-day)	1E-04	(mg/kg-day)	--	
				PAHs													
				BENZ(A)ANTHRACENE	5.90E-01	(mg/kg)	7.08E-09	(mg/kg-day)	7.3E-01	per (mg/kg-day)	5.2E-09	4.95E-07	(mg/kg-day)	NA	(mg/kg-day)	--	
				BENZO(B)FLUORANTHENE	8.20E-01	(mg/kg)	9.83E-09	(mg/kg-day)	7.3E-01	per (mg/kg-day)	7.2E-09	6.88E-07	(mg/kg-day)	NA	(mg/kg-day)	--	
				BENZO(A)PYRENE	3.87E-01	(mg/kg)	4.64E-09	(mg/kg-day)	7.3E+00	per (mg/kg-day)	3.4E-08	3.25E-07	(mg/kg-day)	NA	(mg/kg-day)	--	
				DIBENZ(A,H)ANTHRACENE	6.98E-02	(mg/kg)	8.37E-10	(mg/kg-day)	7.3E+00	per (mg/kg-day)	6.1E-09	5.86E-08	(mg/kg-day)	NA	(mg/kg-day)	--	
				INDENO(1,2,3-C,D)PYRENE	2.92E-01	(mg/kg)	3.50E-09	(mg/kg-day)	7.3E-01	per (mg/kg-day)	2.6E-09	2.45E-07	(mg/kg-day)	NA	(mg/kg-day)	--	
				Exp. Route Total									7.3E-08				
			Exposure Point Total								5.8E-07					2.2E-01	
	Exposure Medium Total								5.8E-07					2.2E-01			
Soil Total	Air	AOC-4	Inhalation	Inorganics													
				ALUMINUM	8.34E-04	(mg/m <sup>3</sup> )	2.72E-03	(ug/m <sup>3</sup> )	NA	per (ug/m <sup>3</sup> )	--	1.90E-04	(mg/m <sup>3</sup> )	5E-03	(mg/m <sup>3</sup> )	3.8E-02	
				ARSENIC	2.28E-07	(mg/m <sup>3</sup> )	7.45E-07	(ug/m <sup>3</sup> )	4.3E-03	per (ug/m <sup>3</sup> )	3.2E-09	5.21E-08	(mg/m <sup>3</sup> )	2E-05	(mg/m <sup>3</sup> )	3.5E-03	
				COBALT	1.58E-07	(mg/m <sup>3</sup> )	5.15E-07	(ug/m <sup>3</sup> )	9.0E-03	per (ug/m <sup>3</sup> )	4.6E-09	3.60E-08	(mg/m <sup>3</sup> )	6E-06	(mg/m <sup>3</sup> )	6.0E-03	
				MANGANESE	9.89E-06	(mg/m <sup>3</sup> )	3.23E-05	(ug/m <sup>3</sup> )	NA	per (ug/m <sup>3</sup> )	--	2.26E-06	(mg/m <sup>3</sup> )	5E-05	(mg/m <sup>3</sup> )	4.5E-02	
				MERCURY	6.31E-08	(mg/m <sup>3</sup> )	2.06E-07	(ug/m <sup>3</sup> )	NA	per (ug/m <sup>3</sup> )	--	1.44E-08	(mg/m <sup>3</sup> )	3E-04	(mg/m <sup>3</sup> )	4.8E-05	
				PAHs													
				BENZ(A)ANTHRACENE	3.16E-08	(mg/m <sup>3</sup> )	1.03E-07	(ug/m <sup>3</sup> )	1.1E-04	per (ug/m <sup>3</sup> )	1.1E-11	7.20E-09	(mg/m <sup>3</sup> )	NA	(mg/m <sup>3</sup> )	--	
				BENZO(B)FLUORANTHENE	4.39E-08	(mg/m <sup>3</sup> )	1.43E-07	(ug/m <sup>3</sup> )	1.1E-04	per (ug/m <sup>3</sup> )	1.6E-11	1.00E-08	(mg/m <sup>3</sup> )	NA	(mg/m <sup>3</sup> )	--	
				BENZO(A)PYRENE	2.07E-08	(mg/m <sup>3</sup> )	6.75E-08	(ug/m <sup>3</sup> )	1.1E-03	per (ug/m <sup>3</sup> )	7.4E-11	4.72E-09	(mg/m <sup>3</sup> )	NA	(mg/m <sup>3</sup> )	--	
				DIBENZ(A,H)ANTHRACENE	3.73E-09	(mg/m <sup>3</sup> )	1.22E-08	(ug/m <sup>3</sup> )	1.1E-03	per (ug/m <sup>3</sup> )	1.3E-11	8.52E-10	(mg/m <sup>3</sup> )	NA	(mg/m <sup>3</sup> )	--	
				INDENO(1,2,3-C,D)PYRENE	1.56E-08	(mg/m <sup>3</sup> )	5.09E-08	(ug/m <sup>3</sup> )	1.1E-04	per (ug/m <sup>3</sup> )	5.6E-12	3.57E-09	(mg/m <sup>3</sup> )	NA	(mg/m <sup>3</sup> )	--	
				Exp. Route Total									8.0E-09				
			Exposure Point Total								8.0E-09					9.3E-02	
	Exposure Medium Total								8.0E-09					9.3E-02			
Soil Total								5.9E-07					3.2E-01				
Total of Receptor Risks Across All Media											5.9E-07	Total of Receptor Hazards Across All Media					3.2E-01

NOTE:  
CSF = Cancer Slope Factor  
1) Dermal intake is "NA" due to no published dermal absorption factor. Please see Table 12 and EPA 2004 guidance.  
EPC = Exposure Point Concentration  
PAH = Polycyclic Aromatic Hydrocarbon  
RfD = Reference Dose  
RfC = Reference Concentration

TABLE 18  
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS  
REASONABLE MAXIMUM EXPOSURE  
AOC-4, FALCON REFINERY SUPERFUND SITE  
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

Scenario Timeframe: Future  
Receptor Population: Resident  
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Constituent of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RID/RIC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Soil	Subsurface Soil	AOC-4	Ingestion	Inorganics	1.27E+00	(mg/kg)	5.96E-07	(mg/kg-day)	1.5E+00	per (mg/kg-day)	8.9E-07	1.74E-06	(mg/kg-day)	3.0E-04	(mg/kg-day)	5.8E-03
				MERCURY	2.12E+00	(mg/kg)	9.94E-07	(mg/kg-day)	NA	per (mg/kg-day)	--	2.90E-06	(mg/kg-day)	1.0E-04	(mg/kg-day)	2.9E-02
				PAHs												
				BENZ(A)ANTHRACENE	1.56E-01	(mg/kg)	1.32E-07	(mg/kg-day)	7.3E-01	per (mg/kg-day)	9.6E-08	2.14E-07	(mg/kg-day)	NA	(mg/kg-day)	--
				BENZO(B)FLUORANTHENE	2.16E-01	(mg/kg)	1.83E-07	(mg/kg-day)	7.3E-01	per (mg/kg-day)	1.3E-07	2.96E-07	(mg/kg-day)	NA	(mg/kg-day)	--
				BENZO(A)PYRENE	1.53E-01	(mg/kg)	1.29E-07	(mg/kg-day)	7.3E+00	per (mg/kg-day)	9.4E-07	2.10E-07	(mg/kg-day)	NA	(mg/kg-day)	--
				DIBENZ(A,H)ANTHRACENE	1.18E-02	(mg/kg)	9.98E-09	(mg/kg-day)	7.3E+00	per (mg/kg-day)	7.3E-08	1.62E-08	(mg/kg-day)	NA	(mg/kg-day)	--
				INDENO(1,2,3-C,D)PYRENE	1.22E-01	(mg/kg)	1.03E-07	(mg/kg-day)	7.3E-01	per (mg/kg-day)	7.5E-08	1.67E-07	(mg/kg-day)	NA	(mg/kg-day)	--
				Exp. Route Total							2.2E-06					3.5E-02
			Dermal <sup>1</sup>	Inorganics	1.27E+00	(mg/kg)	7.14E-08	(mg/kg-day)	1.5E+00	per (mg/kg-day)	1.1E-07	2.08E-07	(mg/kg-day)	3.0E-04	(mg/kg-day)	6.9E-04
				MERCURY	2.12E+00	(mg/kg)	NA	(mg/kg-day)	NA	per (mg/kg-day)	--	NA	(mg/kg-day)	1.0E-04	(mg/kg-day)	--
				PAHs												
				BENZ(A)ANTHRACENE	1.56E-01	(mg/kg)	6.84E-08	(mg/kg-day)	7.3E-01	per (mg/kg-day)	5.0E-08	1.11E-07	(mg/kg-day)	NA	(mg/kg-day)	--
				BENZO(B)FLUORANTHENE	2.16E-01	(mg/kg)	9.47E-08	(mg/kg-day)	7.3E-01	per (mg/kg-day)	6.9E-08	1.53E-07	(mg/kg-day)	NA	(mg/kg-day)	--
				BENZO(A)PYRENE	1.53E-01	(mg/kg)	6.71E-08	(mg/kg-day)	7.3E+00	per (mg/kg-day)	4.9E-07	1.09E-07	(mg/kg-day)	NA	(mg/kg-day)	--
				DIBENZ(A,H)ANTHRACENE	1.18E-02	(mg/kg)	5.17E-09	(mg/kg-day)	7.3E+00	per (mg/kg-day)	3.8E-08	8.38E-09	(mg/kg-day)	NA	(mg/kg-day)	--
				INDENO(1,2,3-C,D)PYRENE	1.22E-01	(mg/kg)	5.35E-08	(mg/kg-day)	7.3E-01	per (mg/kg-day)	3.9E-08	8.67E-08	(mg/kg-day)	NA	(mg/kg-day)	--
				Exp. Route Total							7.9E-07					6.9E-04
			Exposure Point Total													
	Exposure Medium Total														3.5E-02	
	Air	AOC-4	Inhalation	Inorganics	4.55E-09	(mg/m <sup>3</sup> )	1.50E-06	(ug/m <sup>3</sup> )	4.3E-03	per (ug/m <sup>3</sup> )	6.4E-09	4.36E-09	(mg/m <sup>3</sup> )	1.5E-05	(mg/m <sup>3</sup> )	2.9E-04
MERCURY				7.58E-09	(mg/m <sup>3</sup> )	2.49E-06	(ug/m <sup>3</sup> )	NA	per (ug/m <sup>3</sup> )	--	7.27E-09	(mg/m <sup>3</sup> )	3.0E-04	(mg/m <sup>3</sup> )	2.4E-05	
PAHs																
BENZ(A)ANTHRACENE				5.59E-10	(mg/m <sup>3</sup> )	3.31E-07	(ug/m <sup>3</sup> )	1.1E-04	per (ug/m <sup>3</sup> )	3.6E-11	5.36E-10	(mg/m <sup>3</sup> )	NA	(mg/m <sup>3</sup> )	--	
BENZO(B)FLUORANTHENE				7.74E-10	(mg/m <sup>3</sup> )	4.58E-07	(ug/m <sup>3</sup> )	1.1E-04	per (ug/m <sup>3</sup> )	5.0E-11	7.42E-10	(mg/m <sup>3</sup> )	NA	(mg/m <sup>3</sup> )	--	
BENZO(A)PYRENE				5.48E-10	(mg/m <sup>3</sup> )	3.25E-07	(ug/m <sup>3</sup> )	1.1E-03	per (ug/m <sup>3</sup> )	3.6E-10	5.26E-10	(mg/m <sup>3</sup> )	NA	(mg/m <sup>3</sup> )	--	
DIBENZ(A,H)ANTHRACENE				4.23E-11	(mg/m <sup>3</sup> )	2.50E-08	(ug/m <sup>3</sup> )	1.1E-03	per (ug/m <sup>3</sup> )	2.8E-11	4.06E-11	(mg/m <sup>3</sup> )	NA	(mg/m <sup>3</sup> )	--	
INDENO(1,2,3-C,D)PYRENE				4.37E-10	(mg/m <sup>3</sup> )	2.59E-07	(ug/m <sup>3</sup> )	1.1E-04	per (ug/m <sup>3</sup> )	2.8E-11	4.19E-10	(mg/m <sup>3</sup> )	NA	(mg/m <sup>3</sup> )	--	
Exp. Route Total										6.9E-09					3.2E-04	
Exposure Point Total													3.2E-04			
Exposure Medium Total													3.2E-04			
Soil Total														3.6E-02		
														3.6E-02		
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														3.6E-02		

NOTE:  
1) Dermal intake is "NA" due to no published dermal absorption factor. Please see Table 12 and EPA 2004 guidance.  
CSF = Cancer Slope Factor  
EPC = Exposure Point Concentration  
PAH = Polycyclic Aromatic Hydrocarbon  
RID = Reference Dose  
RIC = Reference Concentration

TABLE 19  
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS  
REASONABLE MAXIMUM EXPOSURE  
AOC-4, FALCON REFINERY SUPERFUND SITE  
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

Scenario Timeframe: Future  
Receptor Population: Resident  
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Constituent of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RID/RIC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Soil	Subsurface Soil	AOC-4	Ingestion	Inorganics	1.27E+00	(mg/kg)	1.39E-06	(mg/kg-day)	1.5E+00	per (mg/kg-day)	2.1E-06	1.62E-05	(mg/kg-day)	3E-04	(mg/kg-day)	5.4E-02
				MERCURY	2.12E+00	(mg/kg)	2.32E-06	(mg/kg-day)	NA	per (mg/kg-day)	--	2.71E-05	(mg/kg-day)	1E-04	(mg/kg-day)	2.7E-01
				PAHs												
				BENZ(A)ANTHRACENE	1.56E-01	(mg/kg)	9.06E-07	(mg/kg-day)	7.3E-01	per (mg/kg-day)	6.6E-07	1.99E-06	(mg/kg-day)	NA	(mg/kg-day)	--
				BENZO(B)FLUORANTHENE	2.16E-01	(mg/kg)	1.25E-06	(mg/kg-day)	7.3E-01	per (mg/kg-day)	9.2E-07	2.76E-06	(mg/kg-day)	NA	(mg/kg-day)	--
				BENZO(A)PYRENE	1.53E-01	(mg/kg)	8.89E-07	(mg/kg-day)	7.3E+00	per (mg/kg-day)	6.5E-06	1.96E-06	(mg/kg-day)	NA	(mg/kg-day)	--
				DIBENZ(A,H)ANTHRACENE	1.18E-02	(mg/kg)	6.85E-08	(mg/kg-day)	7.3E+00	per (mg/kg-day)	5.0E-07	1.51E-07	(mg/kg-day)	NA	(mg/kg-day)	--
				INDENO(1,2,3-C,D)PYRENE	1.22E-01	(mg/kg)	7.09E-07	(mg/kg-day)	7.3E-01	per (mg/kg-day)	5.2E-07	1.56E-06	(mg/kg-day)	NA	(mg/kg-day)	--
			Exp. Route Total							1.1E-05					3.2E-01	
			Dermal <sup>1</sup>	Inorganics	1.27E+00	(mg/kg)	1.17E-07	(mg/kg-day)	1.5E+00	per (mg/kg-day)	1.8E-07	1.36E-06	(mg/kg-day)	3.0E-04	(mg/kg-day)	4.5E-03
				MERCURY	2.12E+00	(mg/kg)	NA	(mg/kg-day)	NA	per (mg/kg-day)	--	NA	(mg/kg-day)	1.0E-04	(mg/kg-day)	--
				PAHs												
				BENZ(A)ANTHRACENE	1.56E-01	(mg/kg)	3.30E-07	(mg/kg-day)	7.3E-01	per (mg/kg-day)	2.4E-07	7.26E-07	(mg/kg-day)	NA	(mg/kg-day)	--
				BENZO(B)FLUORANTHENE	2.16E-01	(mg/kg)	4.57E-07	(mg/kg-day)	7.3E-01	per (mg/kg-day)	3.3E-07	1.01E-06	(mg/kg-day)	NA	(mg/kg-day)	--
				BENZO(A)PYRENE	1.53E-01	(mg/kg)	3.23E-07	(mg/kg-day)	7.3E+00	per (mg/kg-day)	2.4E-06	7.12E-07	(mg/kg-day)	NA	(mg/kg-day)	--
				DIBENZ(A,H)ANTHRACENE	1.18E-02	(mg/kg)	2.49E-08	(mg/kg-day)	7.3E+00	per (mg/kg-day)	1.8E-07	5.49E-08	(mg/kg-day)	NA	(mg/kg-day)	--
				INDENO(1,2,3-C,D)PYRENE	1.22E-01	(mg/kg)	2.58E-07	(mg/kg-day)	7.3E-01	per (mg/kg-day)	1.9E-07	5.68E-07	(mg/kg-day)	NA	(mg/kg-day)	--
			Exp. Route Total							3.5E-06					4.5E-03	
			Exposure Point Total								1.5E-05					3.3E-01
	Exposure Medium Total								1.5E-05					3.3E-01		
	Air	AOC-4	Inhalation	Inorganics	4.55E-09	(mg/m <sup>3</sup> )	3.74E-07	(ug/m <sup>3</sup> )	4.3E-03	per (ug/m <sup>3</sup> )	1.6E-09	4.36E-09	(mg/m <sup>3</sup> )	1.5E-05	(mg/m <sup>3</sup> )	2.9E-04
MERCURY				7.58E-09	(mg/m <sup>3</sup> )	6.23E-07	(ug/m <sup>3</sup> )	NA	per (ug/m <sup>3</sup> )	--	7.27E-09	(mg/m <sup>3</sup> )	3.0E-04	(mg/m <sup>3</sup> )	2.4E-05	
PAHs																
BENZ(A)ANTHRACENE				5.59E-10	(mg/m <sup>3</sup> )	2.44E-07	(ug/m <sup>3</sup> )	1.1E-04	per (ug/m <sup>3</sup> )	2.7E-11	5.36E-10	(mg/m <sup>3</sup> )	NA	(mg/m <sup>3</sup> )	--	
BENZO(B)FLUORANTHENE				7.74E-10	(mg/m <sup>3</sup> )	3.37E-07	(ug/m <sup>3</sup> )	1.1E-04	per (ug/m <sup>3</sup> )	3.7E-11	7.42E-10	(mg/m <sup>3</sup> )	NA	(mg/m <sup>3</sup> )	--	
BENZO(A)PYRENE				5.48E-10	(mg/m <sup>3</sup> )	2.39E-07	(ug/m <sup>3</sup> )	1.1E-03	per (ug/m <sup>3</sup> )	2.6E-10	5.26E-10	(mg/m <sup>3</sup> )	NA	(mg/m <sup>3</sup> )	--	
DIBENZ(A,H)ANTHRACENE				4.23E-11	(mg/m <sup>3</sup> )	1.84E-08	(ug/m <sup>3</sup> )	1.1E-03	per (ug/m <sup>3</sup> )	2.0E-11	4.06E-11	(mg/m <sup>3</sup> )	NA	(mg/m <sup>3</sup> )	--	
INDENO(1,2,3-C,D)PYRENE				4.37E-10	(mg/m <sup>3</sup> )	1.90E-07	(ug/m <sup>3</sup> )	1.1E-04	per (ug/m <sup>3</sup> )	2.1E-11	4.19E-10	(mg/m <sup>3</sup> )	NA	(mg/m <sup>3</sup> )	--	
Exp. Route Total										2.0E-09					3.2E-04	
Exposure Point Total								2.0E-09					3.2E-04			
Exposure Medium Total								2.0E-09					3.2E-04			
Soil Total										1.5E-05				3.3E-01		
										1.5E-05				3.3E-01		
										Total of Receptor Hazards Across All Media					3.3E-01	

NOTE:  
1) Dermal intake is "NA" due to no published dermal absorption factor. Please see Table 12 and EPA 2004 guidance.  
CSF = Cancer Slope Factor  
EPC = Exposure Point Concentration  
PAH = Polycyclic Aromatic Hydrocarbon  
RID = Reference Dose  
RIC = Reference Concentration

TABLE 20  
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS  
REASONABLE MAXIMUM EXPOSURE  
AOC-4, FALCON REFINERY SUPERFUND SITE  
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

Scenario Timeframe: Future  
Receptor Population: Construction Worker  
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Constituent of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations						
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient		
							Value	Units	Value	Units		Value	Units	Value	Units			
Soil	Subsurface Soil	AOC-4	Ingestion	Inorganics	1.27E+00	(mg/kg)	5.86E-08	(mg/kg-day)	1.50E+00	per (mg/kg-day)	8.8E-08	4.10E-06	(mg/kg-day)	3.00E-04	(mg/kg-day)	1.4E-02		
				PAHs	2.12E+00	(mg/kg)	9.76E-08	(mg/kg-day)	NA	per (mg/kg-day)	--	6.83E-06	(mg/kg-day)	1.00E-04	(mg/kg-day)	6.8E-02		
				BENZ(A)ANTHRACENE	1.56E-01	(mg/kg)	7.20E-09	(mg/kg-day)	7.30E-01	per (mg/kg-day)	5.3E-09	5.04E-07	(mg/kg-day)	NA	(mg/kg-day)	--		
				BENZO(B)FLUORANTHENE	2.16E-01	(mg/kg)	9.96E-09	(mg/kg-day)	7.30E-01	per (mg/kg-day)	7.3E-09	6.97E-07	(mg/kg-day)	NA	(mg/kg-day)	--		
				BENZO(A)PYRENE	1.53E-01	(mg/kg)	7.06E-09	(mg/kg-day)	7.3E+00	per (mg/kg-day)	5.2E-08	4.94E-07	(mg/kg-day)	NA	(mg/kg-day)	--		
				DIBENZ(A,H)ANTHRACENE	1.18E-02	(mg/kg)	5.44E-10	(mg/kg-day)	7.30E+00	per (mg/kg-day)	4.0E-09	3.81E-08	(mg/kg-day)	NA	(mg/kg-day)	--		
				INDENO(1,2,3-C,D)PYRENE	1.22E-01	(mg/kg)	5.63E-09	(mg/kg-day)	7.30E-01	per (mg/kg-day)	4.1E-09	3.94E-07	(mg/kg-day)	NA	(mg/kg-day)	--		
				Exp. Route Total							1.6E-07					8.2E-02		
				Dermal <sup>1</sup>	Inorganics	1.27E+00	(mg/kg)	3.51E-09	(mg/kg-day)	1.50E+00	per (mg/kg-day)	5.3E-09	2.46E-07	(mg/kg-day)	3.00E-04	(mg/kg-day)	8.2E-04	
					MERCURY	2.12E+00	(mg/kg)	NA	(mg/kg-day)	NA	per (mg/kg-day)	--	NA	(mg/kg-day)	1.00E-04	(mg/kg-day)	--	
			PAHs															
			BENZ(A)ANTHRACENE		1.56E-01	(mg/kg)	1.87E-09	(mg/kg-day)	7.30E-01	per (mg/kg-day)	1.4E-09	1.31E-07	(mg/kg-day)	NA	(mg/kg-day)	--		
			BENZO(B)FLUORANTHENE		2.16E-01	(mg/kg)	2.59E-09	(mg/kg-day)	7.30E-01	per (mg/kg-day)	1.9E-09	1.81E-07	(mg/kg-day)	NA	(mg/kg-day)	--		
			BENZO(A)PYRENE		1.53E-01	(mg/kg)	1.83E-09	(mg/kg-day)	7.3E+00	per (mg/kg-day)	1.3E-08	1.28E-07	(mg/kg-day)	NA	(mg/kg-day)	--		
			DIBENZ(A,H)ANTHRACENE		1.18E-02	(mg/kg)	1.42E-10	(mg/kg-day)	7.30E+00	per (mg/kg-day)	1.0E-09	9.91E-09	(mg/kg-day)	NA	(mg/kg-day)	--		
			INDENO(1,2,3-C,D)PYRENE		1.22E-01	(mg/kg)	1.46E-09	(mg/kg-day)	7.30E-01	per (mg/kg-day)	1.1E-09	1.02E-07	(mg/kg-day)	NA	(mg/kg-day)	--		
			Exp. Route Total								2.4E-08					8.2E-04		
			Exposure Point Total								1.8E-07					8.3E-02		
			Exposure Medium Total							1.8E-07					8.3E-02			
			Air	AOC-4	Inhalation	Inorganics	6.79E-08	(mg/m <sup>3</sup> )	2.22E-07	(ug/m <sup>3</sup> )	4.30E-03	per (ug/m <sup>3</sup> )	9.5E-10	1.55E-08	(ug/m <sup>3</sup> )	1.50E-05	(mg/m <sup>3</sup> )	1.0E-03
						MERCURY	1.13E-07	(mg/m <sup>3</sup> )	3.69E-07	(ug/m <sup>3</sup> )	NA	per (ug/m <sup>3</sup> )	--	2.58E-08	(mg/m <sup>3</sup> )	3.00E-04	(mg/m <sup>3</sup> )	8.6E-05
	PAHs																	
	BENZ(A)ANTHRACENE	8.34E-09				(mg/m <sup>3</sup> )	2.72E-08	(ug/m3)	1.10E-04	per (ug/m3)	3.0E-12	1.90E-09	(mg/m3)	NA	(mg/m3)	--		
	BENZO(B)FLUORANTHENE	1.16E-08				(mg/m <sup>3</sup> )	3.77E-08	(ug/m3)	1.10E-04	per (ug/m3)	4.1E-12	2.64E-09	(mg/m3)	NA	(mg/m3)	--		
	BENZO(A)PYRENE	8.18E-09				(mg/m <sup>3</sup> )	2.67E-08	(ug/m <sup>3</sup> )	1.1E-03	(ug/m <sup>3</sup> )	2.9E-11	1.87E-09	(mg/m3)	NA	(mg/m3)	--		
	DIBENZ(A,H)ANTHRACENE	6.31E-10				(mg/m <sup>3</sup> )	2.06E-09	(ug/m3)	1.10E-03	per (ug/m3)	2.3E-12	1.44E-10	(mg/m3)	NA	(mg/m3)	--		
	INDENO(1,2,3-C,D)PYRENE	6.52E-09				(mg/m <sup>3</sup> )	2.13E-08	(ug/m3)	1.10E-04	per (ug/m3)	2.3E-12	1.49E-09	(mg/m3)	NA	(mg/m3)	--		
Exp. Route Total							9.9E-10					1.1E-03						
Exposure Point Total							9.9E-10					1.1E-03						
Exposure Medium Total							9.9E-10					1.1E-03						
														1.1E-03				
														8.4E-02				
														8.4E-02				
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NOTE:  
1) Dermal intake is "NA" due to no published dermal absorption factor. Please see Table 12 and EPA 2004 guidance.  
CSF = Cancer Slope Factor  
EPC = Exposure Point Concentration  
PAH = Polycyclic Aromatic Hydrocarbon  
RfD = Reference Dose  
RfC = Reference Concentration

TABLE 21  
CALCULATIONS OF AIR CONCENTRATIONS DUE TO DUST ENTRAINMENT FROM SOIL  
RESIDENTIAL EXPOSURES  
AOC-4, FALCON REFINERY SUPERFUND SITE  
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

Model Equations:

Particulate Emission Factor

$$PEF = Q/C \times [(3,600 \text{ s/h}) / (.36 \times (1 - V) \times (U_m/U_t)^3 \times F(x))] =$$

**2.79E+08**

Air Concentration

$$C_{air} = C_{soil}/PEF$$

Where,

$$Q/C = 7.92E+01 \text{ g/m}^2\text{-s per kg/m}^3$$

Inverse Mean Concentration at Center of 0.05 square source for Houston, TX, USEPA 1996

$$V = 5.00E-01 \text{ unitless}$$

Default, USEPA 2013a

$$U_m = 3.49E+00 \text{ m/s}$$

Mean annual wind speed, Houston, TX, USEPA 1996

$$U_t = 1.13E+01 \text{ m/s}$$

Equivalent threshold value of windspeed at 7 m, USEPA 2013a

$$F(x) = 1.94E-01 \text{ unitless}$$

Default, USEPA 2013a

Reference for the model: USEPA Soil Screening Guidance: Technical Background Document. Office of Emergency and Remedial Response. U.S. EPA, 1996.

Chemical	Csoil, Surface Soil	Csoil, Subsurface Soil	Cair, Surface Soil Particulate	Cair, Subsurface Soil Particulate
	RME EPC	RME EPC	RME EPC	RME EPC
	mg/kg	mg/kg	mg/m <sup>3</sup>	mg/m <sup>3</sup>
<b>Inorganics</b>				
ALUMINUM	1.56E+04	NA	5.59E-05	NA
ARSENIC	4.27E+00	1.27E+00	1.53E-08	4.55E-09
COBALT	2.95E+00	NA	1.06E-08	NA
IRON	8.95E+03	NA	3.21E-05	NA
MANGANESE	1.85E+02	NA	6.63E-07	NA
MERCURY	1.18E+00	2.12E+00	4.23E-09	7.58E-09
SELENIUM	NA	NA	NA	NA
<b>PAHs</b>				
BENZ(A)ANTHRACENE	5.90E-01	1.56E-01	2.11E-09	5.59E-10
BENZO(B)FLUORANTHENE	8.20E-01	2.16E-01	2.94E-09	7.74E-10
BENZO(A)PYRENE	3.87E-01	1.53E-01	1.39E-09	5.48E-10
DIBENZ(A,H)ANTHRACENE	6.98E-02	1.18E-02	2.50E-10	4.23E-11
INDENO(1,2,3-C,D)PYRENE	2.92E-01	1.22E-01	1.05E-09	4.37E-10

TABLE 22  
CALCULATIONS OF AIR CONCENTRATIONS DUE TO DUST ENTRAINMENT FROM SOIL  
CONSTRUCTION WORKER - OTHER THAN STANDARD VEHICLE TRAFFIC  
AOC-4, FALCON REFINERY SUPERFUND SITE  
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

Model Equations:

Particulate Emmision Factor	<b>1.87E+07</b>	Calculated using EPA RSL Calculator (Calculations provided in Attachment 3)
Air Concentration		Cair = Csoil/PEF

Where,

Area to be excavated, graded, tilled =	1.70E+00 acres	Entire area of AOC-4
Depth of excavation =	1.50E+00 meters	
Q/C =	1.43E+01 g/m <sup>2</sup> -s per kg/m <sup>3</sup>	calculated
Um =	4.69E+00 m/s	Mean annual wind speed, USEPA 2013a
Ut =	1.13E+01 m/s	Equivalent threshold value of windspeed at 7 m, USEPA 2013a
F(x) =	1.94E-01 unitless	Default, USEPA 2013a

Reference for the model: USEPA Soil Screening Guidance: Technical Background Document. Office of Emergency and Remedial Response. U.S. EPA, 1996.

Chemical	Csoil, Surface Soil	Csoil, Subsurface Soil	Cair, Surface Soil Particulate	Cair, Subsurface Soil Particulate
	RME EPC	RME EPC	RME EPC	RME EPC
	mg/kg	mg/kg	mg/m <sup>3</sup>	mg/m <sup>3</sup>
<b>Inorganics</b>				
ALUMINUM	1.56E+04	NA	8.34E-04	NA
ARSENIC	4.27E+00	1.27E+00	2.28E-07	6.79E-08
COBALT	2.95E+00	NA	1.58E-07	NA
IRON	8.95E+03	NA	4.79E-04	NA
MANGANESE	1.85E+02	NA	9.89E-06	NA
MERCURY	1.18E+00	2.12E+00	6.31E-08	1.13E-07
SELENIUM	NA	NA	NA	NA
<b>PAHs</b>				
BENZ(A)ANTHRACENE	5.90E-01	1.56E-01	3.16E-08	8.34E-09
BENZO(B)FLUORANTHENE	8.20E-01	2.16E-01	4.39E-08	1.16E-08
BENZO(A)PYRENE	3.87E-01	1.53E-01	2.07E-08	8.18E-09
DIBENZ(A,H)ANTHRACENE	6.98E-02	1.18E-02	3.73E-09	6.31E-10
INDENO(1,2,3-C,D)PYRENE	2.92E-01	1.22E-01	1.56E-08	6.52E-09

TABLE 23  
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs  
REASONABLE MAXIMUM EXPOSURE  
AOC-4, FALCON REFINERY SUPERFUND SITE  
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

Location: AOC-4
Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child and Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Dermal	Inhalation	Exposure Routes Total		Primary Target Organ	Ingestion	Dermal	Inhalation	Exposure Routes Total
Soil	Surface Soil	AOC-4 (Child)	Inorganics	--	--	--	NA	Inorganics	Central Nervous System	2.0E-01	--	1.1E-02	2.1E-01
			ALUMINUM	7.0E-06	5.9E-07	5.4E-09	7.6E-06	ARSENIC	Skin	1.8E-01	1.5E-02	9.8E-04	2.0E-01
			COBALT	--	--	7.8E-09	7.8E-09	COBALT	Thyroid	1.3E-01	--	1.7E-03	1.3E-01
			IRON	--	--	--	NA	IRON	Gastrointestinal System	1.6E-01	--	--	1.6E-01
			MANGANESE	--	--	--	NA	MANGANESE	Central Nervous System	5.0E-02	--	1.3E-02	6.3E-02
			MERCURY	--	--	--	NA	MERCURY	Central Nervous System	1.5E-01	--	1.4E-05	1.5E-01
			PAHs					PAHs					
			BENZ(A)ANTHRACENE	2.5E-06	9.1E-07	1.0E-10	3.4E-06	BENZ(A)ANTHRACENE	NA	--	--	--	NA
			BENZO(B)FLUORANTHENE	3.5E-06	1.3E-06	1.4E-10	4.7E-06	BENZO(B)FLUORANTHENE	NA	--	--	--	NA
			BENZO(A)PYRENE	1.6E-05	6.0E-06	6.6E-10	2.2E-05	BENZO(A)PYRENE	NA	--	--	--	NA
			DIBENZ(A,H)ANTHRACENE	3.0E-06	1.1E-06	1.2E-10	4.0E-06	DIBENZ(A,H)ANTHRACENE	NA	--	--	--	NA
			INDENO(1,2,3-C,D)PYRENE	1.2E-06	4.5E-07	5.0E-11	1.7E-06	INDENO(1,2,3-C,D)PYRENE	NA	--	--	--	NA
			(Total for Child)	3.4E-05	1.0E-05	1.4E-08	4.4E-05	(Total for Child)	8.7E-01	1.5E-02	2.6E-02	9.1E-01	
			Surface Soil	AOC-4 (Adult)	Inorganics	--	--	--	NA	Inorganics	Central Nervous System	2.1E-02	--
	ALUMINUM	3.0E-06			3.6E-07	2.2E-08	3.4E-06	ARSENIC	Skin	1.9E-02	2.3E-03	9.8E-04	2.3E-02
	COBALT	--			--	3.1E-08	3.1E-08	COBALT	Thyroid	1.3E-02	--	1.7E-03	1.5E-02
	IRON	--			--	--	NA	IRON	Gastrointestinal System	1.8E-02	--	--	1.8E-02
	MANGANESE	--			--	--	NA	MANGANESE	Central Nervous System	5.4E-03	--	1.3E-02	1.8E-02
	MERCURY	--			--	--	NA	MERCURY	Central Nervous System	1.6E-02	--	1.4E-05	1.6E-02
	PAHs							PAHs					
	BENZ(A)ANTHRACENE	3.6E-07			1.9E-07	1.4E-10	5.5E-07	BENZ(A)ANTHRACENE	NA	--	--	--	NA
	BENZO(B)FLUORANTHENE	5.1E-07			2.6E-07	1.9E-10	7.7E-07	BENZO(B)FLUORANTHENE	NA	--	--	--	NA
	BENZO(A)PYRENE	2.4E-06			1.2E-06	9.0E-10	3.6E-06	BENZO(A)PYRENE	NA	--	--	--	NA
	DIBENZ(A,H)ANTHRACENE	4.3E-07			2.2E-07	1.6E-10	6.5E-07	DIBENZ(A,H)ANTHRACENE	NA	--	--	--	NA
	INDENO(1,2,3-C,D)PYRENE	1.8E-07			9.3E-08	6.8E-11	2.7E-07	INDENO(1,2,3-C,D)PYRENE	NA	--	--	--	NA
	(Total for Adult)	6.9E-06			2.4E-06	5.4E-08	9.3E-06	(Total for Adult)	9.3E-02	2.3E-03	2.6E-02	1.2E-01	
	Surface Soil	AOC-4 (Adult + Child)			Inorganics	1.0E-05	9.5E-07	2.7E-08	1.1E-05				
			COBALT	NA	NA	3.9E-08	3.9E-08						
			PAHs										
			BENZ(A)ANTHRACENE	2.9E-06	1.1E-06	2.4E-10	4.0E-06						
			BENZO(B)FLUORANTHENE	4.0E-06	1.5E-06	3.3E-10	5.5E-06						
			BENZO(A)PYRENE	1.9E-05	7.2E-06	1.6E-09	2.6E-05						
	Total Hazard Index Across Surface Soil (Child)												9.1E-01
	Total Hazard Index Across Surface Soil (Adult)												1.2E-01
	Total Risk Across All Media and All Exposure Routes												5E-05
	Total Hazard Index Across All Media and All Exposure Routes (Child)												1
	Total Hazard Index Across All Media and All Exposure Routes (Adult)												0.1

Total Hazard Index Central Nervous System (Child)	0.4
Total Hazard Index Skin (Child)	0.2
Total Hazard Index Thyroid (Child)	0.1

TABLE 24  
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs  
REASONABLE MAXIMUM EXPOSURE  
AOC-4, FALCON REFINERY SUPERFUND SITE  
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

Location: AOC-4
Scenario Timeframe: Current/Future
Receptor Population: Maintenance Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient						
				Ingestion	Dermal	Inhalation	Exposure Routes Total		Primary Target Organ	Ingestion	Dermal	Inhalation	Exposure Routes Total		
Soil	Surface Soil	AOC-4	Inorganics					Inorganics							
			ALUMINUM	--	--	--	NA	ALUMINUM	Central Nervous System	5.0E-02	--	3.8E-02	8.8E-02		
			ARSENIC	3.0E-07	1.8E-08	3.2E-09	3.2E-07	ARSENIC	Skin	4.6E-02	2.8E-03	3.5E-03	5.2E-02		
			COBALT	--	--	4.6E-09	4.6E-09	COBALT	Thyroid	3.2E-02	--	6.0E-03	3.8E-02		
			MANGANESE	--	--	--	NA	MANGANESE	Central Nervous System	1.3E-02	--	4.5E-02	5.8E-02		
			MERCURY	--	--	--	NA	MERCURY	Central Nervous System	3.8E-02	--	4.8E-05	3.8E-02		
			PAHs					PAHs							
			BENZ(A)ANTHRACENE	2.0E-08	5.2E-09	1.1E-11	2.5E-08	BENZ(A)ANTHRACENE	NA	--	--	--	NA		
			BENZO(B)FLUORANTHENE	2.8E-08	7.2E-09	1.6E-11	3.5E-08	BENZO(B)FLUORANTHENE	NA	--	--	--	NA		
			BENZO(A)PYRENE	1.3E-07	3.4E-08	7.4E-11	1.6E-07	BENZO(A)PYRENE	NA	--	--	--	NA		
			DIBENZ(A,H)ANTHRACENE	2.4E-08	6.1E-09	1.3E-11	3.0E-08	DIBENZ(A,H)ANTHRACENE	NA	--	--	--	NA		
			INDENO(1,2,3-C,D)PYRENE	9.8E-09	2.6E-09	5.6E-12	1.2E-08	INDENO(1,2,3-C,D)PYRENE	NA	--	--	--	NA		
			(Total)	5.1E-07	7.3E-08	8.0E-09	5.9E-07	(Total)	2.2E-01	2.8E-03	9.3E-02	3.2E-01			
			Total Risk Across Surface Soil				5.9E-07				Total Hazard Index Across Surface Soil				3.2E-01
			Total Risk Across All Media and All Exposure Routes				6E-07				Total Hazard Index Across All Media and All Exposure Routes				0.3

NOTE:

NA = Not applicable due to no toxicity values.

-- = No risks calculated for this exposure pathway.

TABLE 25  
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs  
REASONABLE MAXIMUM EXPOSURE  
AOC-4, FALCON REFINERY SUPERFUND SITE  
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

Location: AOC-4
Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child and Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Dermal	Inhalation	Exposure Routes Total		Primary Target Organ	Ingestion	Dermal	Inhalation	Exposure Routes Total
Soil	Subsurface Soil	AOC-4 (Child)	Inorganics					Inorganics					
			ARSENIC	2.1E-06	1.8E-07	1.6E-09	2.3E-06	ARSENIC	Skin	5.4E-02	4.5E-03	2.9E-04	5.9E-02
			MERCURY	--	--	--	NA	MERCURY	Central Nervous System	2.7E-01	--	2.4E-05	2.7E-01
			PAHs					PAHs					
			BENZ(A)ANTHRACENE	6.6E-07	2.4E-07	2.7E-11	9.0E-07	BENZ(A)ANTHRACENE	NA	--	--	--	NA
			BENZO(B)FLUORANTHENE	9.2E-07	3.3E-07	3.7E-11	1.2E-06	BENZO(B)FLUORANTHENE	NA	--	--	--	NA
			BENZO(A)PYRENE	6.5E-06	2.4E-06	2.6E-10	8.8E-06	BENZO(A)PYRENE	NA	--	--	--	NA
			DIBENZ(A,H)ANTHRACENE	5.0E-07	1.8E-07	2.0E-11	6.8E-07	DIBENZ(A,H)ANTHRACENE	NA	--	--	--	NA
			INDENO(1,2,3-C,D)PYRENE	5.2E-07	1.9E-07	2.1E-11	7.1E-07	INDENO(1,2,3-C,D)PYRENE	NA	--	--	--	NA
			(Total for Child)	1.1E-05	3.5E-06	2.0E-09	1.5E-05	(Total for Child)		3.2E-01	4.5E-03	3.2E-04	3.3E-01
	Subsurface Soil	AOC-4 (Adult)	Inorganics					Inorganics					
			ARSENIC	8.9E-07	1.1E-07	6.4E-09	1.0E-06	ARSENIC	Skin	5.8E-03	6.9E-04	2.9E-04	6.8E-03
			MERCURY	--	--	--	NA	MERCURY	Central Nervous System	2.9E-02	--	2.4E-05	2.9E-02
			PAHs					PAHs					
			BENZ(A)ANTHRACENE	9.6E-08	5.0E-08	3.6E-11	1.5E-07	BENZ(A)ANTHRACENE	NA	--	--	--	NA
			BENZO(B)FLUORANTHENE	1.3E-07	6.9E-08	5.0E-11	2.0E-07	BENZO(B)FLUORANTHENE	NA	--	--	--	NA
			BENZO(A)PYRENE	9.4E-07	4.9E-07	3.6E-10	1.4E-06	BENZO(A)PYRENE	NA	--	--	--	NA
			DIBENZ(A,H)ANTHRACENE	7.3E-08	3.8E-08	2.8E-11	1.1E-07	DIBENZ(A,H)ANTHRACENE	NA	--	--	--	NA
			INDENO(1,2,3-C,D)PYRENE	7.5E-08	3.9E-08	2.8E-11	1.1E-07	INDENO(1,2,3-C,D)PYRENE	NA	--	--	--	NA
			(Total for Adult)	2.2E-06	7.9E-07	6.9E-09	3.0E-06	(Total for Adult)		3.5E-02	6.9E-04	3.2E-04	3.6E-02
	Subsurface Soil	AOC-4 (Adult + Child)	Inorganics										
			ARSENIC	3.0E-06	2.8E-07	8.0E-09	3.3E-06						
			PAHs										
			BENZ(A)ANTHRACENE	7.6E-07	2.9E-07	6.3E-11	1.0E-06						
			BENZO(B)FLUORANTHENE	1.0E-06	4.0E-07	8.7E-11	1.5E-06						
			BENZO(A)PYRENE	7.4E-06	2.9E-06	6.2E-10	1.0E-05						
			DIBENZ(A,H)ANTHRACENE	5.7E-07	2.2E-07	4.8E-11	7.9E-07						
	INDENO(1,2,3-C,D)PYRENE	5.9E-07	2.3E-07	4.9E-11	8.2E-07								
	(Total for Child + Adult)				1.3E-05	4.3E-06	8.9E-09	1.8E-05	Total Hazard Index Across Subsurface Soil (Child)				
Total Risk Across Subsurface Soil				1.8E-05				Total Hazard Index Across Subsurface Soil (Adult)					3.6E-02
Total Risk Across All Media and All Exposure Routes				2E-05				Total Hazard Index Across All Media and All Exposure Routes (Child)					0.3
								Total Hazard Index Across All Media and All Exposure Routes (Adult)					0.04

NOTE:

NA = Not applicable due to no toxicity values.

-- = No risks calculated for this exposure pathway.

TABLE 26  
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPC:  
REASONABLE MAXIMUM EXPOSURE  
AOC-4, FALCON REFINERY SUPERFUND SITE  
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

Location: AOC-4
Scenario Timeframe: Future
Receptor Population: Construction Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Dermal	Inhalation	Exposure Routes Total		Primary Target Organ	Ingestion	Dermal	Inhalation	Exposure Routes Total
Soil	Subsurface Soil	AOC-4	Inorganics					Inorganics					
			ARSENIC	8.8E-08	5.3E-09	9.5E-10	9.4E-08	ARSENIC	Skin	1.4E-02	8.2E-04	1.0E-03	1.6E-02
			MERCURY	--	--	--	NA	MERCURY	Central Nervous System	6.8E-02	--	8.6E-05	6.8E-02
			PAHs					PAHs					
			BENZ(A)ANTHRACENE	5.3E-09	1.4E-09	3.0E-12	6.6E-09	BENZ(A)ANTHRACENE	NA	--	--	--	NA
			BENZO(B)FLUORANTHENE	7.3E-09	1.9E-09	4.1E-12	9.2E-09	BENZO(B)FLUORANTHENE	NA	--	--	--	NA
			BENZO(A)PYRENE	5.2E-08	1.3E-08	2.9E-11	6.5E-08	BENZO(A)PYRENE	NA	--	--	--	NA
			DIBENZ(A,H)ANTHRACENE	4.0E-09	1.0E-09	2.3E-12	5.0E-09	DIBENZ(A,H)ANTHRACENE	NA	--	--	--	NA
			INDENO(1,2,3-C,D)PYRENE	4.1E-09	1.1E-09	2.3E-12	5.2E-09	INDENO(1,2,3-C,D)PYRENE	NA	--	--	--	NA
			(Total)	1.6E-07	2.4E-08	9.9E-10	1.9E-07	(Total)		8.2E-02	8.2E-04	1.1E-03	8.4E-02
Total Risk Across Subsurface Soil				1.9E-07				Total Hazard Index Across Subsurface Soil				8.4E-02	
Total Risk Across All Media and All Exposure Routes				2.E-07				Total Hazard Index Across All Media and All Exposure Routes				0.08	

NOTE:

NA = Not applicable due to no toxicity values.  
-- = No risks calculated for this exposure pathway.

**APPENDIX A**

**SAMPLES USED IN THE  
HUMAN HEALTH RISK ASSESSMENT**

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**TABLE A-1 - SAMPLES EVALUATED IN THE HHRA  
AOC-4, FALCON REFINERY SUPERFUND SITE  
INGLESIDE, SAN PATRICIO COUNTY, TEXAS**

Media	Sample Location	Parent Sample	Final Sample Location	Sample Date
<i>AOC 4</i>				
SB	FR-135		FR-135	12/10/2007
SB	MW-17-0.5-2.0		MW-17-0.5-2.0	9/10/2013
SB	MW-17-2.0-3.5		MW-17-2.0-3.5	9/10/2013
SB	SO4-01-0.5-2.0		SO4-01-0.5-2.0	9/10/2013
SB	SO4-01-2.0-3.0		SO4-01-2.0-3.0	9/10/2013
SB	SO4-02-0.5-2.0		SO4-02-0.5-2.0	9/10/2013
SB	SO4-02-2.0-3.0		SO4-02-2.0-3.0	9/10/2013
SB	SO4-03-0.5-2.0		SO4-03-0.5-2.0	9/10/2013
SB	SO4-04-0.5-2.0		SO4-04-0.5-2.0	9/10/2013
SB	SO4-04-2.0-3.0		SO4-04-2.0-3.0	9/10/2013
SB	SO4-05-0.5-2.0		SO4-05-0.5-2.0	9/10/2013
SB	SO4-05-2.0-3.0		SO4-05-2.0-3.0	9/10/2013
SS	MW-17-0.0-0.5		MW-17-0.0-0.5	9/10/2013
SS	SO4-01-0.0-0.5		SO4-01-0.0-0.5	9/10/2013
SS	SO4-01-0.0-0.5 Dup	SO4-01-0.0-0.5	SO4-01-0.0-0.5	9/10/2013
SS	SO4-02-0.0-0.5		SO4-02-0.0-0.5	9/10/2013
SS	SO4-03-0.0-0.5		SO4-03-0.0-0.5	9/10/2013
SS	SO4-04-0.0-0.5		SO4-04-0.0-0.5	9/10/2013
SS	SO4-04-0.0-0.5 Dup	SO4-04-0.0-0.5	SO4-04-0.0-0.5	9/10/2013
SS	SO4-05-0.0-0.5		SO4-05-0.0-0.5	9/10/2013
WG	MW-17		MW-17	9/17/2013
NOTE: SB = Subsurface Soil SS = Surface Soil WG = Ground Water				

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**TABLE A-2. AOC-4, FALCON REFINERY SUPERFUND SITE - SURFACE SOIL DATA**  
**INGLESIDE, SAN PATRICIO COUNTY, TEXAS**

Chemical Name	Unit	Sample Name:	MW-17-0.0-0.5	SO4-01-0.0-0.5	SO4-01-0.0-0.5 Dup	SO4-02-0.0-0.5	SO4-03-0.0-0.5	SO4-04-0.0-0.5	SO4-04-0.0-0.5 Dup	SO4-05-0.0-0.5
		Parent Sample Name:			SO4-01-0.0-0.5				SO4-04-0.0-0.5	
		Sample Depth:	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5
		Date Sampled:	9/10/2013	9/10/2013	9/10/2013	9/10/2013	9/10/2013	9/10/2013	9/10/2013	9/10/2013
INORGANICS										
Aluminum	mg/kg	2430	13300	17000	2000	2210	3930	3920	3450	
Antimony	mg/kg	0.83 UJ	1 UJ	1.3 UJ	1.2 UJ	1.1 UJ	1.1 UJ	0.79 UJ	0.93 UJ	
Arsenic	mg/kg	2	5.7	5.4	0.94	1.2	1.4	2	1.6 J	
Barium	mg/kg	325	727	809	81.4	113	360	352	174	
Beryllium	mg/kg	0.41 U	0.51 U	0.66 U	0.58 U	0.55 U	0.54 U	0.4 U	0.46 U	
Cadmium	mg/kg	0.41 U	0.71	0.9	0.58 U	0.55 U	0.54 U	0.4 U	0.46 U	
Calcium	mg/kg	180000	199000	184000	21700	264000	48300	56200	87700	
Chromium	mg/kg	4.4 J	16.2 J	14.3 J	2	4.3	4.9 J	17.6 J	4 J	
Cobalt	mg/kg	0.89	3.6	3.8	0.72	1.5	1.1	1.7	0.85 J	
Copper	mg/kg	5.1	37.9	23.8	2.8	5.8	10.4	39.8	5 J	
Iron	mg/kg	3770	11500	13000	2250 J	2620 J	4940	5160	7060	
Lead	mg/kg	13.1	31.1	43	12.9	11.6	8.6	7.9	12.2	
Magnesium	mg/kg	2470	5660	6010	1160	2370	1880	1860	1820	
Manganese	mg/kg	108 J	259 J	250 J	65	137	89.7 J	97.8 J	106 J	
Mercury	mg/kg	0.47	1.5	0.97	0.24	0.43	0.27	0.2	0.13	
Nickel	mg/kg	2.6	18.5	11.1	1.7	2.3	3.1	13	2.6 J	
Potassium	mg/kg	852	3340	4000	605	804	753	854	840	
Selenium	mg/kg	2.1 U	2.5 U	3.3 U	2.9 U	2.7 U	2.7 U	2 U	2.3 U	
Silver	mg/kg	0.41 U	0.51 U	0.66 U	0.58 U	0.55 U	0.54 U	0.4 U	0.46 U	
Sodium	mg/kg	4230	1280	1460	449 U	2380	549	625	979	
Thallium	mg/kg	0.41 U	0.51 U	0.66 U	0.58 U	0.55 U	0.54 U	0.4 U	0.46 U	
Vanadium	mg/kg	5.5 J	17.5 J	21.3 J	3.4	6.5	6.8 J	4.7 J	5.1 J	
Zinc	mg/kg	121	560	478	99.6	231	135	105	71.8	
POLYAROMATIC HYDROCARBONS (PAH)										
2-Methylnaphthalene	ug/kg	36 U	46 U	22 U	7.7 U	57 U	73 U	74 U	72 U	
Acenaphthene	ug/kg	21 LJ	46 U	22 U	5.1 LJ	57 U	73 U	32 LJ	72 U	
Acenaphthylene	ug/kg	36 U	46 U	13 LJ	7.3 LJ	28 LJ	61 LJ	74 U	72 U	
Anthracene	ug/kg	63	46 U	13 LJ	16	36 LJ	65 LJ	63 LJ	72 U	
Benzo(a)anthracene	ug/kg	590	81	54	63	100	290	490	100	
Benzo(a)pyrene	ug/kg	500	99	71	53	160	360	450	82	
Benzo(b)fluoranthene	ug/kg	820	210	150	100	260	570	800	150	
Benzo(g,h,i)perylene	ug/kg	210	66	52	22	150	200	210	34 LJ	
Benzo(k)fluoranthene	ug/kg	220	55	43	28	72	160	270	43 LJ	
Chrysene	ug/kg	600	120	90	70	190	290	520	100	
Dibenz(a,h)anthracene	ug/kg	76	22 LJ	16 LJ	10	53 LJ	64 LJ	75	72 U	
Fluoranthene	ug/kg	1400	180	98	160	250	430	950	210	
Fluorene	ug/kg	15 LJ	46 U	22 U	3.7 LJ	57 U	73 U	74 U	72 U	
Indeno(1,2,3-cd)pyrene	ug/kg	350	110	82	50	150	320	350	70 LJ	
Naphthalene	ug/kg	36 U	46 U	22 U	7.7 U	57 U	73 U	74 U	72 U	
Phenanthrene	ug/kg	350	43 LJ	26	49	89	170	230	92	
Pyrene	ug/kg	1100	140	90	120	190	380	690	150	
SEMI-VOLATILE ORGANIC COMPOUNDS (SVOC)										
1,1-Biphenyl	ug/kg	920 U	1200 U	1100 U	400 U	980 U	940 U	950 U	190 U	
1,2,4,5-Tetrachlorobenzene	ug/kg	920 U	1200 U	1100 U	400 U	980 U	940 U	950 U	190 U	
2,3,4,6-Tetrachlorophenol	ug/kg	920 U	1200 U	1100 U	400 U	980 U	940 U	950 U	190 U	
2,4,5-Trichlorophenol	ug/kg	920 U	1200 U	1100 U	400 U	980 U	940 U	950 U	190 U	
2,4,6-Trichlorophenol	ug/kg	920 U	1200 U	1100 U	400 U	980 U	940 U	950 U	190 U	
2,4-Dichlorophenol	ug/kg	920 U	1200 U	1100 U	400 U	980 U	940 U	950 U	190 U	
2,4-Dimethylphenol	ug/kg	920 U	1200 U	1100 U	400 U	980 U	940 U	950 U	190 U	
2,4-Dinitrophenol	ug/kg	1800 U	2300 U	2200 U	770 U	1900 U	1800 U	1800 U	360 U	

**TABLE A-2. AOC-4, FALCON REFINERY SUPERFUND SITE - SURFACE SOIL DATA**  
**INGLESIDE, SAN PATRICIO COUNTY, TEXAS**

Sample Name: Parent Sample Name:		MW-17-0.0-0.5	SO4-01-0.0-0.5	SO4-01-0.0-0.5 Dup	SO4-02-0.0-0.5	SO4-03-0.0-0.5	SO4-04-0.0-0.5	SO4-04-0.0-0.5 Dup	SO4-05-0.0-0.5
Sample Depth:		0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5
Date Sampled:		9/10/2013	9/10/2013	9/10/2013	9/10/2013	9/10/2013	9/10/2013	9/10/2013	9/10/2013
Chemical Name	Unit								
2,4-Dinitrotoluene	ug/kg	920 U	1200 U	1100 U	400 U	980 U	940 U	950 U	190 U
2,6-Dinitrotoluene	ug/kg	920 U	1200 U	1100 U	400 U	980 U	940 U	950 U	190 U
2-Chloronaphthalene	ug/kg	920 U	1200 U	1100 U	400 U	980 U	940 U	950 U	190 U
2-Chlorophenol	ug/kg	920 U	1200 U	1100 U	400 U	980 U	940 U	950 U	190 U
2-Methylphenol	ug/kg	920 U	1200 U	1100 U	400 U	980 U	940 U	950 U	190 U
2-Nitroaniline	ug/kg	1800 U	2300 U	2200 U	770 U	1900 U	1800 U	1800 U	360 U
2-Nitrophenol	ug/kg	920 U	1200 U	1100 U	400 U	980 U	940 U	950 U	190 U
3,3-Dichlorobenzidine	ug/kg	920 U	1200 U	1100 U	400 U	980 U	940 U	950 U	190 U
3-Nitroaniline	ug/kg	1800 U	2300 U	2200 U	770 U	1900 U	1800 U	1800 U	360 U
4,6-Dinitro-2-methylphenol	ug/kg	1800 U	2300 U	2200 U	770 U	1900 U	1800 U	1800 U	360 U
4-Bromophenyl phenyl ether	ug/kg	920 U	1200 U	1100 U	400 U	980 U	940 U	950 U	190 U
4-Chloro-3-methylphenol	ug/kg	920 U	1200 U	1100 U	400 U	980 U	940 U	950 U	190 U
4-Chloroaniline	ug/kg	920 U	1200 U	1100 U	400 U	980 U	940 U	950 U	190 U
4-Chlorophenyl phenyl ether	ug/kg	920 U	1200 U	1100 U	400 U	980 U	940 U	950 U	190 U
4-Methylphenol	ug/kg	920 U	1200 U	1100 U	400 U	980 U	940 U	950 U	190 U
4-Nitroaniline	ug/kg	1800 U	2300 U	2200 U	770 U	1900 U	1800 U	1800 U	360 U
4-Nitrophenol	ug/kg	1800 U	2300 U	2200 U	770 U	1900 U	1800 U	1800 U	360 U
Acetophenone	ug/kg	920 U	1200 U	1100 U	400 U	980 U	940 U	950 U	62 LJ
Atrazine	ug/kg	920 U	1200 U	1100 U	400 U	980 U	940 U	950 U	190 U
Benzaldehyde	ug/kg	920 U	1200 U	1100 U	400 U	980 U	940 U	950 U	66 LJ
Bis(2-chloroethoxy)methane	ug/kg	920 U	1200 U	1100 U	400 U	980 U	940 U	950 U	190 U
Bis(2-chloroethyl)ether	ug/kg	920 U	1200 U	1100 U	400 U	980 U	940 U	950 U	190 U
Bis(2-chloroisopropyl) ether	ug/kg	920 U	1200 U	1100 U	400 U	980 U	940 U	950 U	190 U
Bis(2-ethylhexyl) phthalate	ug/kg	920 U	1200 U	1100 U	400 U	980 U	220 LJ	130 LJ	94 LJ
Butyl benzyl phthalate	ug/kg	920 U	1200 U	1100 U	400 U	980 U	940 U	950 U	190 U
Caprolactum	ug/kg	920 U	1200 U	1100 U	400 U	980 U	940 U	950 U	190 U
Carbazole	ug/kg	920 U	1200 U	1100 U	400 U	980 U	940 U	950 U	19 LJ
Dibenzofuran	ug/kg	920 U	1200 U	1100 U	400 U	980 U	940 U	950 U	190 U
Diethyl phthalate	ug/kg	920 U	1200 U	1100 U	400 U	980 U	940 U	950 U	190 U
Dimethyl phthalate	ug/kg	920 U	1200 U	1100 U	400 U	980 U	150 LJ	950 U	20 LJ
Di-n-butyl phthalate	ug/kg	920 U	1200 U	1100 U	400 U	980 U	940 U	950 U	190 U
Di-n-octyl phthalate	ug/kg	920 U	1200 U	1100 U	400 U	980 U	940 U	950 U	190 U
Hexachlorobenzene	ug/kg	920 U	1200 U	1100 U	400 U	980 U	940 U	950 U	190 U
Hexachlorobutadiene	ug/kg	920 U	1200 U	1100 U	400 U	980 U	940 U	950 U	190 U
Hexachlorocyclopentadiene	ug/kg	920 U	1200 U	1100 U	400 U	980 U	940 U	950 U	190 U
Hexachloroethane	ug/kg	920 U	1200 U	1100 U	400 U	980 U	940 U	950 U	190 U
Isophorone	ug/kg	920 U	1200 U	1100 U	400 U	980 U	940 U	950 U	190 U
Nitrobenzene	ug/kg	920 U	1200 U	1100 U	400 U	980 U	940 U	950 U	190 U
N-Nitrosodi-n-propylamine	ug/kg	920 U	1200 U	1100 U	400 U	980 U	940 U	950 U	190 U
N-Nitrosodiphenylamine	ug/kg	920 U	1200 U	1100 U	400 U	980 U	940 U	950 U	190 U
Pentachlorophenol	ug/kg	73 U	94 U	45 U	16 U	120 U	150 U	150 U	150 U
Phenol	ug/kg	920 U	1200 U	1100 U	400 U	980 U	940 U	950 U	33 LJ
<b>VOLATILE ORGANIC COMPOUNDS (VOC)</b>									
1,1,1-Trichloroethane	ug/kg	5.3 U	7.9 U	8.7 U	5.1 U	4.9 U	5.9 U	5.9 U	5.6 U
1,1,2,2-Tetrachloroethane	ug/kg	5.3 U	7.9 U	8.7 U	5.1 U	4.9 U	5.9 U	5.9 U	5.6 U
1,1,2-Trichloro-1,2,2-trifluoroethane	ug/kg	5.3 U	7.9 U	8.7 U	5.1 U	4.9 U	5.9 U	5.9 U	5.6 U
1,1,2-Trichloroethane	ug/kg	5.3 U	7.9 U	8.7 U	5.1 U	4.9 U	5.9 U	5.9 U	5.6 U
1,1-Dichloroethane	ug/kg	5.3 U	7.9 U	8.7 U	5.1 U	4.9 U	5.9 U	5.9 U	5.6 U
1,1-Dichloroethene	ug/kg	5.3 U	7.9 U	8.7 U	5.1 U	4.9 U	5.9 U	5.9 U	5.6 U

**TABLE A-2. AOC-4, FALCON REFINERY SUPERFUND SITE - SURFACE SOIL DATA  
INGLESIDE, SAN PATRICIO COUNTY, TEXAS**

Sample Name: Parent Sample Name:	Unit	MW-17-0.0-0.5	SO4-01-0.0-0.5	SO4-01-0.0-0.5 Dup	SO4-02-0.0-0.5	SO4-03-0.0-0.5	SO4-04-0.0-0.5	SO4-04-0.0-0.5 Dup	SO4-05-0.0-0.5
		0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5
		9/10/2013	9/10/2013	9/10/2013	9/10/2013	9/10/2013	9/10/2013	9/10/2013	9/10/2013
		9/10/2013	9/10/2013	9/10/2013	9/10/2013	9/10/2013	9/10/2013	9/10/2013	9/10/2013
Chemical Name	Unit								
1,2,3-Trichlorobenzene	ug/kg	5.3 U	R	R	5.1 U	4.9 U	5.9 U	5.9 U	5.6 U
1,2,4-Trichlorobenzene	ug/kg	5.3 U	R	R	5.1 U	4.9 U	5.9 U	5.9 U	5.6 U
1,2-Dibromo-3-chloropropane (DBCP)	ug/kg	5.3 U	R	R	5.1 U	4.9 U	5.9 U	5.9 U	5.6 U
1,2-Dibromoethane (Ethylene dibromide [EDB])	ug/kg	5.3 U	7.9 U	8.7 U	5.1 U	4.9 U	5.9 U	5.9 U	5.6 U
1,2-Dichlorobenzene	ug/kg	5.3 U	R	R	5.1 U	4.9 U	5.9 U	5.9 U	5.6 U
1,2-Dichloroethane	ug/kg	5.3 U	7.9 U	8.7 U	5.1 U	4.9 U	5.9 U	5.9 U	5.6 U
1,2-Dichloroethene (cis)	ug/kg	5.3 U	7.9 U	8.7 U	5.1 U	4.9 U	5.9 U	5.9 U	5.6 U
1,2-Dichloroethene (trans)	ug/kg	5.3 U	7.9 U	8.7 U	5.1 U	4.9 U	5.9 U	5.9 U	5.6 U
1,2-Dichloropropane	ug/kg	5.3 U	7.9 U	8.7 U	5.1 U	4.9 U	5.9 U	5.9 U	5.6 U
1,3-Dichlorobenzene	ug/kg	5.3 U	R	R	5.1 U	4.9 U	5.9 U	5.9 U	5.6 U
1,3-Dichloropropene (cis)	ug/kg	5.3 U	7.9 U	8.7 U	5.1 U	4.9 U	5.9 U	5.9 U	5.6 U
1,3-Dichloropropene (trans)	ug/kg	5.3 U	7.9 U	8.7 U	5.1 U	4.9 U	5.9 U	5.9 U	5.6 U
1,4-Dichlorobenzene	ug/kg	5.3 U	R	R	5.1 U	4.9 U	5.9 U	5.9 U	5.6 U
1,4-Dioxane	ug/kg	110 UJv	160 UJv	170 UJv	100 UJv	97 UJv	120 UJv	120 UJv	110 UJv
2-Butanone (Methyl ethyl ketone)	ug/kg	11 U	14 LJ	17 U	10 U	9.7 U	12 U	12 U	11 U
2-Hexanone	ug/kg	11 U	16 U	17 U	10 U	9.7 U	12 U	12 U	11 U
4-Methyl-2-pentanone (Methyl isobutyl ketone [MIBK])	ug/kg	11 U	16 U	17 U	10 U	9.7 U	12 U	12 U	11 U
Acetone	ug/kg	11 U	16 U	17 U	10 U	9.7 U	12 U	12 U	11 U
Benzene	ug/kg	5.3 U	7.9 U	8.7 U	5.1 U	4.9 U	5.9 U	5.9 U	5.6 U
Bromochloromethane	ug/kg	5.3 U	7.9 U	8.7 U	5.1 U	4.9 U	5.9 U	5.9 U	5.6 U
Bromodichloromethane	ug/kg	5.3 U	7.9 U	8.7 U	5.1 U	4.9 U	5.9 U	5.9 U	5.6 U
Bromoform	ug/kg	5.3 U	R	R	5.1 U	4.9 U	5.9 U	5.9 U	5.6 U
Bromomethane (Methyl bromide)	ug/kg	5.3 U	7.9 U	8.7 U	5.1 U	4.9 U	5.9 U	5.9 U	5.6 U
Carbon disulfide	ug/kg	5.3 U	7.9 U	8.7 U	5.1 U	4.9 U	5.9 U	5.9 U	5.6 U
Carbon tetrachloride	ug/kg	5.3 U	7.9 U	8.7 U	5.1 U	4.9 U	5.9 U	5.9 U	5.6 U
Chlorobenzene	ug/kg	5.3 U	7.9 U	8.7 U	5.1 U	4.9 U	5.9 U	5.9 U	5.6 U
Chloroethane (Ethyl chloride)	ug/kg	5.3 U	7.9 U	8.7 U	5.1 U	4.9 U	5.9 U	5.9 U	5.6 U
Chloroform	ug/kg	5.3 U	7.9 U	8.7 U	5.1 U	4.9 U	5.9 U	5.9 U	5.6 U
Chloromethane (Methyl chloride)	ug/kg	5.3 U	7.9 U	8.7 U	5.1 U	4.9 U	5.9 U	5.9 U	5.6 U
Cyclohexane	ug/kg	5.3 U	7.9 U	8.7 U	5.1 U	4.9 U	5.9 U	5.9 U	5.6 U
Dibromochloromethane (Chlorodibromomethane)	ug/kg	5.3 U	7.9 U	8.7 U	5.1 U	4.9 U	5.9 U	5.9 U	5.6 U
Dichlorodifluoromethane	ug/kg	5.3 U	7.9 U	8.7 U	5.1 U	4.9 U	5.9 U	5.9 U	5.6 U
Ethylbenzene	ug/kg	5.3 U	3.7 LJ	1.6 LJ	5.1 U	4.9 U	5.9 U	5.9 U	5.6 U
Isopropylbenzene (Cumene)	ug/kg	5.3 U	0.33 LJ	8.7 U	5.1 U	4.9 U	5.9 U	5.9 U	5.6 U
m- & p-Xylenes	ug/kg	0.15 LJ	35 J	14	5.1 U	4.9 U	5.9 U	5.9 U	5.6 U
Methyl acetate	ug/kg	5.3 U	7.9 U	8.7 U	5.1 U	4.9 U	5.9 U	5.9 U	5.6 U
Methylcyclohexane	ug/kg	5.3 U	7.9 U	8.7 U	5.1 U	4.9 U	5.9 U	5.9 U	5.6 U
Methylene chloride	ug/kg	5.3 U	7.9 U	8.7 U	5.1 U	4.9 U	5.9 U	5.9 U	5.6 U
Methyl-tertiary-butyl ether (MtBE)	ug/kg	5.3 U	7.9 U	8.7 U	5.1 U	4.9 U	5.9 U	5.9 U	5.6 U
o-Xylene	ug/kg	5.3 U	12	4.2 LJ	5.1 U	4.9 U	5.9 U	5.9 U	5.6 U
Styrene	ug/kg	5.3 U	7.9 U	8.7 U	5.1 U	4.9 U	5.9 U	5.9 U	5.6 U
Tetrachloroethene (PCE)	ug/kg	5.3 U	7.9 U	8.7 U	5.1 U	4.9 U	5.9 U	5.9 U	5.6 U
Toluene	ug/kg	5.3 U	7.9 U	8.7 U	5.1 U	4.9 U	5.9 U	5.9 U	5.6 U
Trichloroethene (TCE)	ug/kg	5.3 U	1.2 LJ	8.7 U	5.1 U	4.9 U	5.9 U	5.9 U	5.6 U
Trichlorofluoromethane	ug/kg	0.25 LJ	0.5 LJ	0.48 LJ	5.1 U	4.9 U	0.27 LJ	0.18 LJ	0.23 LJ
Vinyl chloride	ug/kg	5.3 U	7.9 U	8.7 U	5.1 U	4.9 U	5.9 U	5.9 U	5.6 U
Qualifiers: U = Not detected J = Indicates an estimated value L = Result is biased low R = Result is unusable									

**TABLE A-3. AOC 4, FALCON REFINERY SUPERFUND SITE - SURFACE SOIL DATA**  
**INGLESIDE, SAN PATRICIO, TEXAS**

Chemical Name	Unit	Sample Name:	MW-17-0.5-2.0	MW-17-2.0-3.5	SO4-01-0.5-2.0	SO4-01-2.0-3.0	SO4-02-0.5-2.0	SO4-02-2.0-3.0	SO4-03-0.5-2.0	SO4-04-0.5-2.0	SO4-04-2.0-3.0	SO4-05-0.5-2.0	SO4-05-2.0-3.0
		Parent Sample Name:											
		Sample Depth:	0.5-2.0	2.0-3.5	0.5-2.0	2.0-3.0	0.5-2.0	2.0-3.0	0.5-2.0	0.5-2.0	2.0-3.0	0.5-2.0	2.0-3.0
		Date Sampled:	9/10/2013	9/10/2013	9/10/2013	9/10/2013	9/10/2013	9/10/2013	9/10/2013	9/10/2013	9/10/2013	9/10/2013	9/10/2013
INORGANICS													
Aluminum	mg/kg	2980	1210	1980	818	1320	1870	1140	2720	1950	2190	3630	
Antimony	mg/kg	1 UJ	1 UJ	0.88 UJ	0.96 UJ	0.89 UJ	1 UJ	0.83 UJ	1 UJ	0.9 UJ	1.1 UJ	1 UJ	
Arsenic	mg/kg	2.1	0.5 LJ	1.9	0.41 LJ	0.84 J	0.83 J	0.98 J	0.86	1	0.82	1	
Barium	mg/kg	162	146	203	5.3	25.4	6.3	68.4	94.9	165	17.4	8.5	
Beryllium	mg/kg	0.5 U	0.52 U	0.44 U	0.48 U	0.44 U	0.5 U	0.42 U	0.52 U	0.45 U	0.54 U	0.52 U	
Cadmium	mg/kg	0.5 U	0.52 U	0.44 U	0.48 U	0.44 U	0.5 U	0.42 U	0.52 U	0.45 U	0.54 U	0.52 U	
Calcium	mg/kg	67200	20200	140000	574	19700 J	5010 J	146000 J	34900	67500	17400	7660	
Chromium	mg/kg	2.7 J	1.7	1.6 J	0.58 LJ	1.1 J	1.6 J	1.3 J	2 J	1.8 J	2.3 J	3.4 J	
Cobalt	mg/kg	0.97	0.52 U	0.56	0.48 U	0.47	0.56	0.58	0.53	0.45 U	0.54 U	0.75	
Copper	mg/kg	2.2	1.2	4.1	0.96 U	1	0.59 LJ	2.6	1.6	1.2	1.1 U	1 U	
Iron	mg/kg	2830	1140 J	1650	761 J	1220	1750	1340	2890	1650	2010	3130	
Lead	mg/kg	6.8	15.8	8.5	0.77	11.7	1.6	6.5	3.3	3.4	5.7	1.9	
Magnesium	mg/kg	884	626	1200	188 LJ	449 LJ	1190 J	1210 J	1330	1340	1100	2090	
Manganese	mg/kg	59.1 J	21.3	93.9 J	7.5	30.3 J	56.8 J	120 J	68.8 J	74.6 J	54 J	79.7 J	
Mercury	mg/kg	0.15	0.071 LJ	0.11	0.11 U	2.3 J	0.012 LJ	0.074 LJ	0.052 LJ	0.032 LJ	0.016 LJ	0.006 LJ	
Nickel	mg/kg	1.7	0.78	0.89	0.34 LJ	0.76 J	1.2 J	1.1 J	1.1	0.88	1.1	1.8	
Potassium	mg/kg	665	463 U	518	408 U	354 LJ	577	302 LJ	706	552	679	1110	
Selenium	mg/kg	2.5 U	2.6 U	2.2 U	2.4 U	2.2 U	2.5 U	2.1 U	2.6 U	2.2 U	2.7 U	2.6 U	
Silver	mg/kg	0.5 U	0.52 U	0.44 U	0.48 U	0.44 U	0.5 U	0.42 U	0.52 U	0.45 U	0.54 U	0.52 U	
Sodium	mg/kg	1330	495	1120	408 U	651	321 LJ	1010	1130	1050	443 LJ	471 LJ	
Thallium	mg/kg	0.5 U	0.52 U	0.44 U	0.48 U	0.44 U	0.5 U	0.42 U	0.52 U	0.45 U	0.54 U	0.52 U	
Vanadium	mg/kg	5.1 J	2.6 U	3.2 J	2.4 U	1.6 LJ	2.4 LJ	1.7 LJ	4.2 J	3.3 J	3.2 J	5.5 J	
Zinc	mg/kg	51.5	10.1	16.6	0.96 U	79.1	4.2	21.7	30.6	13.9	66.1	5.7	
POLYAROMATIC HYDROCARBONS (PAH)													
2-Methylnaphthalene	ug/kg	1.9 LJ	3.8 U	4 U	3.8 U	3.7 U	4 U	7.3 U	18 U	20 U	110 U	3.9 U	
Acenaphthene	ug/kg	13	3.8 U	4 U	3.8 U	3.7 U	4 U	7.3 U	18 U	110	110 U	3.9 U	
Acenaphthylene	ug/kg	3.8	2.7 LJ	4 U	3.8 U	4.7	4 U	9	9.8 LJ	12 LJ	110 U	3.9 U	
Anthracene	ug/kg	32	3.7 LJ	2.3 LJ	3.8 U	6.4	4 U	11	14 LJ	28	130	1.6 LJ	
Benzo(a)anthracene	ug/kg	180	9.8	8	3.8 U	15	4 U	8.6	50	50	230	4.5	
Benzo(a)pyrene	ug/kg	140	10	7	3.8 U	19	4 U	12	49	53	250	3.3 LJ	
Benzo(b)fluoranthene	ug/kg	270	17	11	3.8 U	35	4 U	29	92	110	280	4.8	
Benzo(g,h,i)perylene	ug/kg	68 LJ	5	1.7 LJ	3.8 U	7.7	4 U	4.3 LJ	24	21	89 LJ	3.9 U	
Benzo(k)fluoranthene	ug/kg	74	5.3	3.4 LJ	3.8 U	10	4 U	8.6	26	29	130	1.7 LJ	
Chrysene	ug/kg	200	11	8.8	3.8 U	19	4 U	15	56	55	210	4.2	
Dibenz(a,h)anthracene	ug/kg	28	2 LJ	4 U	3.8 U	4.7	4 U	3.1 LJ	10 LJ	10 LJ	110 U	3.9 U	
Fluoranthene	ug/kg	390	20	14	3.8 U	27	4 U	8.7	77	100	480	9.4	
Fluorene	ug/kg	7.6	3.8 U	4 U	3.8 U	3.7 U	4 U	7.3 U	18 U	20 U	110 U	3.9 U	
Indeno(1,2,3-cd)pyrene	ug/kg	100	9	5.8	3.8 U	22	4 U	16	48	46	200	2.5 LJ	
Naphthalene	ug/kg	2.5 LJ	3.8 U	4 U	3.8 U	3.7 U	4 U	7.3 U	18 U	20 U	110 U	1.9 LJ	
Phenanthrene	ug/kg	190	14	6.6	3.8 U	11	4 U	7.3 U	19	33	300	7	
Pyrene	ug/kg	310	16	14	3.8 U	22	4 U	12	70	89	380	9	
SEMI-VOLATILE ORGANIC COMPOUNDS (SVOC)													
1,1-Biphenyl	ug/kg	190 U	200 U	200 U	190 U	190 U	200 U	380 U	190 U	1000 U	190 U	200 U	
1,2,4,5-Tetrachlorobenzene	ug/kg	190 U	200 U	200 U	190 U	190 U	200 U	380 U	190 U	1000 U	190 U	200 U	
2,3,4,6-Tetrachlorophenol	ug/kg	190 U	200 U	200 U	190 U	190 U	200 U	380 U	190 U	1000 U	190 U	200 U	
2,4,5-Trichlorophenol	ug/kg	190 U	200 U	200 U	190 U	190 U	200 U	380 U	190 U	1000 U	190 U	200 U	
2,4,6-Trichlorophenol	ug/kg	190 U	200 U	200 U	190 U	190 U	200 U	380 U	190 U	1000 U	190 U	200 U	
2,4-Dichlorophenol	ug/kg	190 U	200 U	200 U	190 U	190 U	200 U	380 U	190 U	1000 U	190 U	200 U	
2,4-Dimethylphenol	ug/kg	190 U	200 U	200 U	190 U	190 U	200 U	380 U	190 U	1000 U	190 U	200 U	
2,4-Dinitrophenol	ug/kg	370 U	380 U	400 U	380 U	370 U	400 U	730 U	360 U	2000 U	370 U	390 U	
2,4-Dinitrotoluene	ug/kg	190 U	200 U	200 U	190 U	190 U	200 U	380 U	190 U	1000 U	190 U	200 U	
2,6-Dinitrotoluene	ug/kg	190 U	200 U	200 U	190 U	190 U	200 U	380 U	190 U	1000 U	190 U	200 U	

**TABLE A-3. AOC 4, FALCON REFINERY SUPERFUND SITE - SURFACE SOIL DATA**  
**INGLESIDE, SAN PATRICIO, TEXAS**

Sample Name:		MW-17-0.5-2.0	MW-17-2.0-3.5	SO4-01-0.5-2.0	SO4-01-2.0-3.0	SO4-02-0.5-2.0	SO4-02-2.0-3.0	SO4-03-0.5-2.0	SO4-04-0.5-2.0	SO4-04-2.0-3.0	SO4-05-0.5-2.0	SO4-05-2.0-3.0
Parent Sample Name:												
Sample Depth:		0.5-2.0	2.0-3.5	0.5-2.0	2.0-3.0	0.5-2.0	2.0-3.0	0.5-2.0	0.5-2.0	2.0-3.0	0.5-2.0	2.0-3.0
Date Sampled:		9/10/2013	9/10/2013	9/10/2013	9/10/2013	9/10/2013	9/10/2013	9/10/2013	9/10/2013	9/10/2013	9/10/2013	9/10/2013
Chemical Name	Unit											
2-Chloronaphthalene	ug/kg	190 U	200 U	200 U	190 U	190 U	200 U	380 U	190 U	1000 U	190 U	200 U
2-Chlorophenol	ug/kg	190 U	200 U	200 U	190 U	190 U	200 U	380 U	190 U	1000 U	190 U	200 U
2-Methylphenol	ug/kg	190 U	200 U	200 U	190 U	190 U	200 U	380 U	190 U	1000 U	190 U	200 U
2-Nitroaniline	ug/kg	370 U	380 U	400 U	380 U	370 U	400 U	730 U	360 U	2000 U	370 U	390 U
2-Nitrophenol	ug/kg	190 U	200 U	200 U	190 U	190 U	200 U	380 U	190 U	1000 U	190 U	200 U
3,3-Dichlorobenzidine	ug/kg	190 U	200 U	200 U	190 U	190 U	200 U	380 U	190 U	1000 U	190 U	200 U
3-Nitroaniline	ug/kg	370 U	380 U	400 U	380 U	370 U	400 U	730 U	360 U	2000 U	370 U	390 U
4,6-Dinitro-2-methylphenol	ug/kg	370 U	380 U	400 U	380 U	370 U	400 U	730 U	360 U	2000 U	370 U	390 U
4-Bromophenyl phenyl ether	ug/kg	190 U	200 U	200 U	190 U	190 U	200 U	380 U	190 U	1000 U	190 U	200 U
4-Chloro-3-methylphenol	ug/kg	190 U	200 U	200 U	190 U	190 U	200 U	380 U	190 U	1000 U	190 U	200 U
4-Chloroaniline	ug/kg	190 U	200 U	200 U	190 U	190 U	200 U	380 U	190 U	1000 U	190 U	200 U
4-Chlorophenyl phenyl ether	ug/kg	190 U	200 U	200 U	190 U	190 U	200 U	380 U	190 U	1000 U	190 U	200 U
4-Methylphenol	ug/kg	190 U	200 U	200 U	190 U	190 U	200 U	380 U	190 U	1000 U	190 U	200 U
4-Nitroaniline	ug/kg	370 U	380 U	400 U	380 U	370 U	400 U	730 U	360 U	2000 U	370 U	390 U
4-Nitrophenol	ug/kg	370 U	380 U	400 U	380 U	370 U	400 U	730 U	360 U	2000 U	370 U	390 U
Acetophenone	ug/kg	22 LJ	200 U	200 U	190 U	20 LJ	200 U	380 U	25 LJ	1000 U	78 LJ	46 LJ
Atrazine	ug/kg	190 U	200 U	200 U	190 U	190 U	200 U	380 U	190 U	1000 U	190 U	200 U
Benzaldehyde	ug/kg	23 LJ	200 U	200 U	190 U	30 LJ	200 U	380 U	31 LJ	1000 U	74 LJ	62 LJ
Bis(2-chloroethoxy)methane	ug/kg	190 U	200 U	200 U	190 U	190 U	200 U	380 U	190 U	1000 U	190 U	200 U
Bis(2-chloroethyl)ether	ug/kg	190 U	200 U	200 U	190 U	190 U	200 U	380 U	190 U	1000 U	190 U	200 U
Bis(2-chloroisopropyl) ether	ug/kg	190 U	200 U	200 U	190 U	190 U	200 U	380 U	190 U	1000 U	190 U	200 U
Bis(2-ethylhexyl) phthalate	ug/kg	190 U	200 U	200 U	190 U	190 U	200 U	380 U	22 LJ	1000 U	190 U	200 U
Butyl benzyl phthalate	ug/kg	190 U	200 U	200 U	190 U	190 U	200 U	380 U	190 U	1000 U	190 U	200 U
Caprolactum	ug/kg	190 U	200 U	200 U	190 U	190 U	200 U	380 U	190 U	1000 U	190 U	200 U
Carbazole	ug/kg	32 LJ	200 U	200 U	190 U	190 U	200 U	380 U	190 U	1000 U	26 LJ	200 U
Dibenzofuran	ug/kg	190 U	200 U	200 U	190 U	190 U	200 U	380 U	190 U	1000 U	190 U	200 U
Diethyl phthalate	ug/kg	190 U	200 U	200 U	190 U	190 U	200 U	380 U	190 U	1000 U	190 U	200 U
Dimethyl phthalate	ug/kg	190 U	22 LJ	200 U	190 U	190 U	200 U	380 U	190 U	1000 U	190 U	200 U
Di-n-butyl phthalate	ug/kg	190 U	200 U	200 U	190 U	190 U	200 U	380 U	190 U	1000 U	190 U	200 U
Di-n-octyl phthalate	ug/kg	190 U	200 U	200 U	190 U	190 U	200 U	380 U	190 U	1000 U	190 U	200 U
Hexachlorobenzene	ug/kg	190 U	200 U	200 U	190 U	190 U	200 U	380 U	190 U	1000 U	190 U	200 U
Hexachlorobutadiene	ug/kg	190 U	200 U	200 U	190 U	190 U	200 U	380 U	190 U	1000 U	190 U	200 U
Hexachlorocyclopentadiene	ug/kg	190 U	200 U	200 U	190 U	190 U	200 U	380 U	190 U	1000 U	190 U	200 U
Hexachloroethane	ug/kg	190 U	200 U	200 U	190 U	190 U	200 U	380 U	190 U	1000 U	190 U	200 U
Isophorone	ug/kg	190 U	200 U	200 U	190 U	190 U	200 U	380 U	190 U	1000 U	190 U	200 U
Nitrobenzene	ug/kg	190 U	200 U	200 U	190 U	190 U	200 U	380 U	190 U	1000 U	190 U	200 U
N-Nitrosodi-n-propylamine	ug/kg	190 U	200 U	200 U	190 U	190 U	200 U	380 U	190 U	1000 U	190 U	200 U
N-Nitrosodiphenylamine	ug/kg	190 U	200 U	200 U	190 U	190 U	200 U	380 U	190 U	1000 U	190 U	200 U
Pentachlorophenol	ug/kg	7.5 U	7.7 U	8 U	7.6 U	7.6 U	8 U	15 U	37 U	41 U	230 U	8 U
Phenol	ug/kg	190 U	200 U	200 U	190 U	190 U	200 U	380 U	190 U	1000 U	190 U	200 U
<b>VOLATILE ORGANIC COMPOUNDS (VOC)</b>												
1,1,1-Trichloroethane	ug/kg	5.1 U	5.1 U	7.6 U	5.1 U	5.2 U	6.2 U	5.3 U	7.7 U	5.4 U	5.2 U	5 U
1,1,2,2-Tetrachloroethane	ug/kg	5.1 U	5.1 U	7.6 U	5.1 U	5.2 U	6.2 U	5.3 U	7.7 U	5.4 U	5.2 U	5 U
1,1,2-Trichloro-1,2,2-trifluoroethane	ug/kg	5.1 U	5.1 U	7.6 U	5.1 U	5.2 U	6.2 U	5.3 U	7.7 U	5.4 U	5.2 U	5 U
1,1,2-Trichloroethane	ug/kg	5.1 U	5.1 U	7.6 U	5.1 U	5.2 U	6.2 U	5.3 U	7.7 U	5.4 U	5.2 U	5 U
1,1-Dichloroethane	ug/kg	5.1 U	5.1 U	7.6 U	5.1 U	5.2 U	6.2 U	5.3 U	7.7 U	5.4 U	5.2 U	5 U
1,1-Dichloroethene	ug/kg	5.1 U	5.1 U	7.6 U	5.1 U	5.2 U	6.2 U	5.3 U	7.7 U	5.4 U	5.2 U	5 U
1,2,3-Trichlorobenzene	ug/kg	5.1 U	5.1 U	7.6 U	5.1 U	5.2 U	6.2 U	5.3 U	7.7 U	5.4 U	5.2 U	5 U
1,2,4-Trichlorobenzene	ug/kg	5.1 U	5.1 U	7.6 U	5.1 U	5.2 U	6.2 U	5.3 U	7.7 U	5.4 U	5.2 U	5 U
1,2-Dibromo-3-chloropropane (DBCP)	ug/kg	5.1 U	5.1 U	7.6 U	5.1 U	5.2 U	6.2 U	5.3 U	7.7 U	5.4 U	5.2 U	5 U
1,2-Dibromoethane (Ethylene dibromide [EDB])	ug/kg	5.1 U	5.1 U	7.6 U	5.1 U	5.2 U	6.2 U	5.3 U	7.7 U	5.4 U	5.2 U	5 U

**TABLE A-3. AOC 4, FALCON REFINERY SUPERFUND SITE - SURFACE SOIL DATA**  
**INGLESIDE, SAN PATRICIO, TEXAS**

		Sample Name:	MW-17-0.5-2.0	MW-17-2.0-3.5	SO4-01-0.5-2.0	SO4-01-2.0-3.0	SO4-02-0.5-2.0	SO4-02-2.0-3.0	SO4-03-0.5-2.0	SO4-04-0.5-2.0	SO4-04-2.0-3.0	SO4-05-0.5-2.0	SO4-05-2.0-3.0
		Parent Sample Name:											
		Sample Depth:	0.5-2.0	2.0-3.5	0.5-2.0	2.0-3.0	0.5-2.0	2.0-3.0	0.5-2.0	0.5-2.0	2.0-3.0	0.5-2.0	2.0-3.0
		Date Sampled:	9/10/2013	9/10/2013	9/10/2013	9/10/2013	9/10/2013	9/10/2013	9/10/2013	9/10/2013	9/10/2013	9/10/2013	9/10/2013
Chemical Name	Unit												
1,2-Dichlorobenzene	ug/kg		5.1 U	5.1 U	7.6 U	5.1 U	5.2 U	6.2 U	5.3 U	7.7 U	5.4 U	5.2 U	5 U
1,2-Dichloroethane	ug/kg		5.1 U	5.1 U	7.6 U	5.1 U	5.2 U	6.2 U	5.3 U	7.7 U	5.4 U	5.2 U	5 U
1,2-Dichloroethene (cis)	ug/kg		5.1 U	5.1 U	7.6 U	5.1 U	5.2 U	6.2 U	5.3 U	7.7 U	5.4 U	5.2 U	5 U
1,2-Dichloroethene (trans)	ug/kg		5.1 U	5.1 U	7.6 U	5.1 U	5.2 U	6.2 U	5.3 U	7.7 U	5.4 U	5.2 U	5 U
1,2-Dichloropropane	ug/kg		5.1 U	5.1 U	7.6 U	5.1 U	5.2 U	6.2 U	5.3 U	7.7 U	5.4 U	5.2 U	5 U
1,3-Dichlorobenzene	ug/kg		5.1 U	5.1 U	7.6 U	5.1 U	5.2 U	6.2 U	5.3 U	7.7 U	5.4 U	5.2 U	5 U
1,3-Dichloropropene (cis)	ug/kg		5.1 U	5.1 U	7.6 U	5.1 U	5.2 U	6.2 U	5.3 U	7.7 U	5.4 U	5.2 U	5 U
1,3-Dichloropropene (trans)	ug/kg		5.1 U	5.1 U	7.6 U	5.1 U	5.2 U	6.2 U	5.3 U	7.7 U	5.4 U	5.2 U	5 U
1,4-Dichlorobenzene	ug/kg		5.1 U	5.1 U	7.6 U	5.1 U	5.2 U	6.2 U	5.3 U	7.7 U	5.4 U	5.2 U	5 U
1,4-Dioxane	ug/kg		100 UJv	100 UJv	150 UJv	100 UJv	100 UJv	120 UJv	110 UJv	150 UJv	110 UJv	100 UJv	100 UJv
2-Butanone (Methyl ethyl ketone)	ug/kg		10 U	10 U	15 U	10 U	10 U	12 U	11 U	15 U	11 U	10 U	10 U
2-Hexanone	ug/kg		10 U	10 U	15 U	10 U	10 U	12 U	11 U	15 U	11 U	10 U	10 U
4-Methyl-2-pentanone (Methyl isobutyl ketone [MIBK])	ug/kg		10 U	10 U	15 U	10 U	10 U	12 U	11 U	15 U	11 U	10 U	10 U
Acetone	ug/kg		10 U	10 U	7.5 LJ	6 LJ	10 U	12 U	11 U	15 U	11 U	6.9 LJ	6.9 LJ
Benzene	ug/kg		5.1 U	5.1 U	7.6 U	5.1 U	5.2 U	6.2 U	5.3 U	7.7 U	5.4 U	5.2 U	5 U
Bromochloromethane	ug/kg		5.1 U	5.1 U	7.6 U	5.1 U	5.2 U	6.2 U	5.3 U	7.7 U	5.4 U	5.2 U	5 U
Bromodichloromethane	ug/kg		5.1 U	5.1 U	7.6 U	5.1 U	5.2 U	6.2 U	5.3 U	7.7 U	5.4 U	5.2 U	5 U
Bromoform	ug/kg		5.1 U	5.1 U	7.6 U	5.1 U	5.2 U	6.2 U	5.3 U	7.7 U	5.4 U	5.2 U	5 U
Bromomethane (Methyl bromide)	ug/kg		5.1 U	5.1 U	7.6 U	5.1 U	5.2 U	6.2 U	5.3 U	7.7 U	5.4 U	5.2 U	5 U
Carbon disulfide	ug/kg		5.1 U	5.1 U	7.6 U	0.39 LJ	5.2 U	6.2 U	5.3 U	7.7 U	5.4 U	5.2 U	5 U
Carbon tetrachloride	ug/kg		5.1 U	5.1 U	7.6 U	5.1 U	5.2 U	6.2 U	5.3 U	7.7 U	5.4 U	5.2 U	5 U
Chlorobenzene	ug/kg		5.1 U	5.1 U	7.6 U	5.1 U	5.2 U	6.2 U	5.3 U	7.7 U	5.4 U	5.2 U	5 U
Chloroethane (Ethyl chloride)	ug/kg		5.1 U	5.1 U	7.6 U	5.1 U	5.2 U	6.2 U	5.3 U	7.7 U	5.4 U	5.2 U	5 U
Chloroform	ug/kg		5.1 U	5.1 U	7.6 U	5.1 U	5.2 U	6.2 U	5.3 U	7.7 U	0.55 LJ	5.2 U	5 U
Chloromethane (Methyl chloride)	ug/kg		5.1 U	5.1 U	7.6 U	5.1 U	5.2 U	6.2 U	5.3 U	7.7 U	5.4 U	5.2 U	5 U
Cyclohexane	ug/kg		5.1 U	5.1 U	7.6 U	5.1 U	5.2 U	6.2 U	5.3 U	7.7 U	5.4 U	5.2 U	5 U
Dibromochloromethane (Chlorodibromomethane)	ug/kg		5.1 U	5.1 U	7.6 U	5.1 U	5.2 U	6.2 U	5.3 U	7.7 U	5.4 U	5.2 U	5 U
Dichlorodifluoromethane	ug/kg		5.1 U	5.1 U	7.6 U	5.1 U	5.2 U	6.2 U	5.3 U	7.7 U	5.4 U	5.2 U	5 U
Ethylbenzene	ug/kg		5.1 U	5.1 U	7.6 U	5.1 U	5.2 U	6.2 U	5.3 U	7.7 U	5.4 U	5.2 U	5 U
Isopropylbenzene (Cumene)	ug/kg		5.1 U	5.1 U	7.6 U	5.1 U	5.2 U	6.2 U	5.3 U	7.7 U	5.4 U	5.2 U	5 U
m- & p-Xylenes	ug/kg		0.16 LJ	5.1 U	0.17 LJ	5.1 U	5.2 U	6.2 U	5.3 U	0.67 LJ	0.16 LJ	0.14 LJ	5 U
Methyl acetate	ug/kg		5.1 U	5.1 U	7.6 U	5.1 U	5.2 U	6.2 U	5.3 U	7.7 U	5.4 U	5.2 U	5 U
Methylcyclohexane	ug/kg		5.1 U	5.1 U	7.6 U	5.1 U	5.2 U	6.2 U	5.3 U	7.7 U	5.4 U	5.2 U	5 U
Methylene chloride	ug/kg		5.1 U	5.1 U	7.6 U	5.1 U	5.2 U	6.2 U	5.3 U	7.7 U	5.4 U	5.2 U	5 U
Methyl-tertiary-butyl ether (MtBE)	ug/kg		5.1 U	5.1 U	7.6 U	5.1 U	5.2 U	6.2 U	5.3 U	7.7 U	5.4 U	5.2 U	0.96 LJ
o-Xylene	ug/kg		5.1 U	5.1 U	7.6 U	5.1 U	5.2 U	6.2 U	5.3 U	7.7 U	5.4 U	5.2 U	5 U
Styrene	ug/kg		5.1 U	5.1 U	7.6 U	5.1 U	5.2 U	6.2 U	5.3 U	7.7 U	5.4 U	5.2 U	5 U
Tetrachloroethene (PCE)	ug/kg		5.1 U	5.1 U	7.6 U	5.1 U	5.2 U	6.2 U	5.3 U	7.7 U	5.4 U	5.2 U	5 U
Toluene	ug/kg		5.1 U	5.1 U	7.6 U	5.1 U	5.2 U	6.2 U	5.3 U	7.7 U	5.4 U	5.2 U	5 U
Trichloroethene (TCE)	ug/kg		5.1 U	5.1 U	7.6 U	5.1 U	5.2 U	6.2 U	5.3 U	7.7 U	5.4 U	5.2 U	5 U
Trichlorofluoromethane	ug/kg		0.33 LJ	0.27 LJ	0.35 LJ	0.14 LJ	5.2 U	6.2 U	5.3 U	0.18 LJ	0.19 LJ	0.34 LJ	0.15 LJ
Vinyl chloride	ug/kg		5.1 U	5.1 U	7.6 U	5.1 U	5.2 U	6.2 U	5.3 U	7.7 U	5.4 U	5.2 U	5 U
Qualifiers:													
U = Not detected													
J = Indicates an estimated value													
L = Result is biased low													
R = Result is unusable													

**APPENDIX B**

**BACKGROUND SAMPLES**

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**TABLE B-1**  
**BACKGROUND SAMPLE LOCATIONS**  
**AOC-4, FALCON REFINERY SITE**

Sample Name	Parent Sample	Sample Date
<i>Surface Soil</i>		
FR-252		16 January 2008
FR-253		16 January 2008
FR-255		16 January 2008
FR-259		16 January 2008
FR-262		16 January 2008
TWB-01-0.0-0.5		13 September 2013
TWB-02-0.0-0.5		13 September 2013
TWB-03-0.0-0.5		13 September 2013
TWB-03-0.0-0.5 Dup	TWB-03-0.0-0.5	13 September 2013
TWB-04-0.0-0.5		13 September 2013
TWB-05-0.0-0.5		13 September 2013
TWB-06-0.0-0.5		13 September 2013
TWB-06-0.0-0.5 Dup	TWB-06-0.0-0.5	13 September 2013
TWB-07-0.0-0.5		13 September 2013
TWB-08-0.0-0.5		14 September 2013
TWB-09-0.0-0.5		14 September 2013
TWB-09-0.0-0.5 Dup	TWB-09-0.0-0.5	14 September 2013
TWB-10-0.0-0.5		14 September 2013
<i>Subsurface Soil</i>		
FR-254		16 January 2008
FR-256		16 January 2008
FR-260		16 January 2008
FR-263		16 January 2008
TWB-01-0.5-2.0		13 September 2013
TWB-01-2.0-3.0		13 September 2013
TWB-02-0.5-2.0		13 September 2013
TWB-02-2.0-5.0		13 September 2013
TWB-03-0.5-2.0		13 September 2013
TWB-03-2.0-4.0		13 September 2013
TWB-04-0.5-2.0		13 September 2013
TWB-05-0.5-2.0		13 September 2013
TWB-05-2.0-5.0		13 September 2013
TWB-06-0.5-2.0		13 September 2013
TWB-06-2.0-5.0		13 September 2013
TWB-07-0.5-2.0		13 September 2013
TWB-07-2.0-5.0		13 September 2013
TWB-08-0.5-2.0		14 September 2013
TWB-08-2.0-5.0		14 September 2013
TWB-09-0.5-2.0		14 September 2013
TWB-09-2.0-5.0		14 September 2013
TWB-10-0.5-2.0		14 September 2013
TWB-10-2.0-5.0		14 September 2013
<i>Ground Water</i>		
FR-257		16 January 2008
FR-258		16 January 2008
FR-261		16 January 2008
FR-264		16 January 2008
TWB-01		17 September 2013
TWB-02 R		18 September 2013
TWB-03 R		17 September 2013
TWB-04		17 September 2013
TWB-04 Dup	TWB-04	17 September 2013
TWB-05		17 September 2013
TWB-06		18 September 2013
TWB-07		17 September 2013
TWB-08		17 September 2013
TWB-09		17 September 2013
TWB-10		17 September 2013

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TABLE B-2. FALCON REFINERY SUPERFUND SITE - SURFACE SOIL BACKGROUND DATA  
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

Sample Name: Parent Sample Name: Sample Depth: Date Sampled:	FR-252	FR-253	FR-255	FR-259	FR-262	TWB-01-0.0-0.5	TWB-02-0.0-0.5	TWB-03-0.0-0.5	TWB-03-0.0-0.5 Dup	TWB-04-0.0-0.5	TWB-05-0.0-0.5	TWB-06-0.0-0.5	TWB-06-0.0-0.5 Dup	TWB-07-0.0-0.5	TWB-08-0.0-0.5	TWB-09-0.0-0.5	TWB-09-0.0-0.5 Dup	TWB-10-0.0-0.5			
									TWB-03-0.0-0.5				TWB-06-0.0-0.5				TWB-09-0.0-0.5				
						0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5			
		1/16/2008	1/16/2008	1/16/2008	1/16/2008	1/16/2008	9/13/2013	9/13/2013	9/13/2013	9/13/2013	9/13/2013	9/13/2013	9/13/2013	9/13/2013	9/13/2013	9/14/2013	9/14/2013	9/14/2013	9/14/2013		
Chemical Name	Unit																				
INORGANICS																					
Aluminum	mg/kg	2280	2230	918	762	10500	6480	3700	2780	2530	1630	2140	4790	3270	2740	1020	965	737	3580		
Antimony	mg/kg	0.84 B	0.75 B	NR	NR	NR	1.7 J	0.87 UJ	0.8 UJ	1 UJ	1 UJ	1 UJ	0.81 UJ	1.1 UJ	1.1 UJ	0.77 UJ	0.95 UJ	0.87 UJ	1.1 UJ		
Arsenic	mg/kg	NR	0.33 B	NR	0.29 B	2.8	4.6 J-	0.66 J-	0.89 J-	0.97 J-	1.3	0.94 J-	1.3	1.4	0.53 U	0.42 J-	0.48 UJ	0.44 UJ	1.3 J-		
Barium	mg/kg	33	38.5	19.6 B	43	1520	543 J	346 J	228 J	230 J	169	115 J	1070	1020	20.6	26.8 J	25.5 J	28.9 J	169 J		
Beryllium	mg/kg	0.093 B	0.075 B	NR	NR	0.44 B	0.59 U	0.43 U	0.4 U	0.5 U	0.5 U	0.52 U	0.4 U	0.54 U	0.53 U	0.39 U	0.48 U	0.44 U	0.56 U		
Cadmium	mg/kg	NR	NR	NR	NR	0.68	0.59 U	0.43 U	0.4 U	0.5 U	0.5 U	0.52 U	0.4 U	0.54 U	0.53 U	0.39 U	0.48 U	0.44 U	0.56 U		
Calcium	mg/kg	252000	195000	8540	835	110000	85700	33900	41800	32000	212000	69600	653000	129000	10900	6740	19700	187000	100000		
Chromium	mg/kg	4.5	4.1	0.9 B	0.94 B	92.3	12	4.8	5.2	5.7	38.9 J	5.1	25.1 J	15 J	1.5 J	4.1	1.1	1.7	6.2		
Chromium, hexavalent	mg/kg	NR	NR	NR	NR	2.1 B	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR		
Cobalt	mg/kg	0.73 B	0.44 B	NR	NR	4.8 B	2.1	0.89	0.86	0.91	1.2	0.83	1.8	1.7	0.53 U	0.39 U	0.48 U	0.44 U	1.1		
Copper	mg/kg	4.8	5.4	0.92 B	4.2	16.6	39.9 J	5.9 J	7.5 J	7.5 J	11.3	6.5 J	12.4	13.8	3.3	2.5 J	1.8 J	2.5 J	13.6 J		
Iron	mg/kg	1610	1550	604	625	34500	10500	3460	8920	3430	4180	5570	6550	7660	2020	929	987	708	4170		
Lead	mg/kg	5.1	5.7	5	4	19.6	27.3	23.3	30.6	32.3	27.4	22.4	30.2	48	5	6.5	9.4	10.7	19.1		
Magnesium	mg/kg	1220	1000	199 B	105 B	5140	2410	1010	1030	870	1620	1410	1870	1930	471 LJ	292 LJ	378 LJ	650	1450		
Manganese	mg/kg	74.5	55.9	35.4	18.1	345	219	114	133	102	145	107	190	183	31.9	17	23.6	32.7	93.4		
Mercury	mg/kg	0.012 B	0.01 B	0.0065 B	0.0044 B	0.0062 B	0.025 LJ	0.015 LJ	0.012 LJ	0.01 LJ	0.012 LJ	0.014 LJ	0.011 LJ	0.0098 LJ	0.012 LJ	0.0065 LJ	0.0091 LJ	0.0073 LJ	0.0094 LJ		
Nickel	mg/kg	3.4 B	2.6 B	0.44 B	0.3 B	7.8	6.9	4.4	3.2	3.4	5.1 J	3.5	13.4 J	7.6 J	0.91 J	1.2	1.3	1.2	4.4		
Potassium	mg/kg	647	616	130 B	183 B	2500	1020	696	509	453	384 U	528 U	975	642	476 U	403 U	462 U	348 U	952		
Selenium	mg/kg	1.3	1.3	NR	NR	1 B	2.9 U	2.2 U	2 U	2.5 U	2.5 U	2.6 U	2 U	2.7 U	2.7 U	1.9 U	2.4 U	2.2 U	2.8 U		
Silver	mg/kg	NR	NR	NR	NR	0.11 B	0.59 U	0.43 U	0.4 U	0.5 U	0.5 U	0.52 U	0.4 U	0.54 U	0.53 U	0.39 U	0.48 U	0.44 U	0.56 U		
Sodium	mg/kg	35 B	48.6 B	NR	NR	1280	490 U	540 U	427 U	432 U	384 U	528 U	270 U	408 U	476 U	403 U	462 U	348 U	473 U		
Thallium	mg/kg	NR	NR	NR	NR	NR	0.59 U	0.43 U	0.4 U	0.5 U	0.5 U	0.52 U	0.4 U	0.54 U	0.53 U	0.39 U	0.48 U	0.44 U	0.56 U		
Vanadium	mg/kg	6.6	5.8	1.2 B	0.93 B	23.7	13.9	4.9	5.2	5.7	2.9 J	5.9	7.2 J	7.9 J	1.8 LJ	2.8	6.3	2.3	8.6		
Zinc	mg/kg	41.3	48.1	9.2	18.2	3630	203 J	54.8 J	71.5 J	68.6 J	101	66.1 J	117	118	17.3	18.7 J	11.4 J	16.6 J	71 J		
SEMI-VOLATILE ORGANIC COMPOUNDS (SVOC)																					
Ethyl Ether	mg/kg	0.0069	0.0078	NR	NR	0.0119	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR		
VOLATILE ORGANIC COMPOUNDS (VOC)																					
1,2,4-Trimethylbenzene	mg/kg	NR	NR	0.0037 J	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR		
Acetone	ug/kg	538	147	NR	NR	298	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR		
Ethylbenzene	ug/kg	NR	NR	1.9 J	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR		
Methylene chloride	ug/kg	419 J	154	NR	NR	196	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR		
Toluene	ug/kg	NR	NR	1.7 J	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR		
Xylene (total)	mg/kg	NR	NR	0.0071 J	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR		
Qualifiers: U = Not detected J = Indicates an estimated value L = Result is biased low R = Result is unusable NR = No result																					

TABLE B-3. FALCON REFINERY SUPERFUND SITE - SUBSURFACE SOIL BACKGROUND DATA  
INGLESIDE, SAN PATRICIO COUNTY, TEXAS

Sample Date:		FR-254	FR-256	FR-260	FR-263	TWB-01-0.5-2.0	TWB-01-2.0-3.0	TWB-02-0.5-2.0	TWB-02-2.0-5.0	TWB-03-0.5-2.0	TWB-03-2.0-4.0	TWB-04-0.5-2.0	TWB-05-0.5-2.0	TWB-05-2.0-5.0	TWB-06-0.5-2.0	TWB-06-2.0-5.0	TWB-07-0.5-2.0	TWB-07-2.0-5.0	TWB-08-0.5-2.0	TWB-08-2.0-5.0	TWB-09-0.5-2.0	TWB-09-2.0-5.0	TWB-10-0.5-2.0	TWB-10-2.0-5.0	
Parent Sample Name:																									
Sample Depth:						0.5-2.0	2.0-3.0	0.5-2.0	2.0-5.0	0.5-2.0	2.0-4.0	0.5-2.0	0.5-2.0	2.0-5.0	0.5-2.0	2.0-5.0	0.5-2.0	2.0-5.0	0.5-2.0	2.0-5.0	0.5-2.0	2.0-5.0	0.5-2.0	2.0-5.0	
Date Sampled:		1/16/2008	1/16/2008	1/16/2008	1/16/2008	9/13/2013	9/13/2013	9/13/2012	9/13/2013	9/13/2013	9/13/2013	9/13/2013	9/13/2013	9/13/2013	9/13/2013	9/13/2013	9/13/2013	9/14/2013	9/14/2013	9/14/2013	9/14/2013	9/14/2013	9/14/2013	9/14/2013	
Chemical Name	Unit																								
INORGANICS																									
Aluminum	mg/kg	865	797	694	3150	4240	535	776	8990	743	650	396	302	663	322	1140	302	306	300	249	493	931	2880	1120	
Antimony	mg/kg	NR	NR	NR	NR	1 UJ	1 UJ	1 UJ	0.9 UJ	0.78 UJ	0.82 UJ	0.9 UJ	0.7 UJ	0.79 UJ	0.9 UJ	0.77 UJ	0.84 UJ	1 UJ	0.93 UJ	0.9 UJ	0.7 UJ	0.8 UJ	0.77 UJ	0.97 UJ	0.79 UJ
Arsenic	mg/kg	NR	NR	NR	0.99 B	0.91 J-	0.51 U	0.51 UJ	0.7 J-	0.39 UJ	0.41 UJ	0.45 UJ	0.35 U	0.39 UJ	0.45 U	0.38 U	0.42 U	0.52 U	0.46 UJ	0.35 UJ	0.4 UJ	0.38 UJ	0.64 J	0.4 UJ	
Barium	mg/kg	8.8 B	5.8 B	23.4	68.6	112 J	5.1 U	12.3 J	22.2 J	21.2 J	4.6 J	4.5 UJ	6.8	5.5 J	5.9	7.2	6.9	5.2 U	5.4 J	3.5 UJ	4 UJ	8.9 J	121 J	4 UJ	
Beryllium	mg/kg	NR	NR	NR	0.13 B	0.5 U	0.51 U	0.51 U	0.45 U	0.39 U	0.41 U	0.45 U	0.35 U	0.39 U	0.45 U	0.38 U	0.42 U	0.52 U	0.46 U	0.35 U	0.4 U	0.38 U	0.49 U	0.4 U	
Cadmium	mg/kg	NR	NR	NR	NR	0.5 U	0.51 U	0.51 U	0.45 U	0.39 U	0.41 U	0.45 U	0.35 U	0.39 U	0.45 U	0.38 U	0.42 U	0.52 U	0.46 U	0.35 U	0.4 U	0.38 U	0.49 U	0.4 U	
Calcium	mg/kg	578 B	156 B	302 B	16600	52900	474 U	2430	821	7260	478 U	397 U	378 U	413 U	519 U	429 U	1130	520 U	694	475 U	339 U	3080	61000 J	464 UJ	
Chromium	mg/kg	0.85 B	1.8	0.74 B	2.5	4.1	0.28 LJ	0.53 LJ	3.9	0.57 LJ	0.42 LJ	0.43 LJ	0.64 LJ	0.21 LJ	0.12 LJ	0.27 LJ	0.18 LJ	1 UJ	0.19 LJ	0.027 LJ	0.093 LJ	0.4 LJ	4.4 J	0.36 LJ	
Chromium, hexavalent	mg/kg	3	NR	2.7	2.5	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Cobalt	mg/kg	NR	NR	NR	1 B	1.1	0.51 U	0.51 U	3.2	0.39 U	0.41 U	0.45 U	0.35 U	0.39 U	0.45 U	0.38 U	0.42 U	0.52 U	0.46 U	0.35 U	0.4 U	0.38 U	1.3	0.4 U	
Copper	mg/kg	1.1 B	0.69 B	0.85 B	2.3 B	3.2 J	0.16 LJ	1 UJ	1.1 J	0.78 UJ	0.82 UJ	0.9 UJ	0.22 LJ	0.79 UJ	0.12 LJ	0.14 LJ	2.8	1 U	2.3 J	0.7 UJ	0.8 UJ	0.77 UJ	2.5	0.79 U	
Iron	mg/kg	643	330	691	2340	3030	221	721	5570	474	240	192	640	178	130	230	534	83.8	224	73.3	181	521	1720	265	
Lead	mg/kg	2.8	1.8	2.3	4.2	27.3	0.82	4.7	4.9	8.4	1.6	1	1.2	1.2	1	1.2	5.7	0.94	2.5	1.1	1.3	3	6.7	1.7	
Magnesium	mg/kg	111 B	33.1 B	74.6 B	1110	1290	28.5 LJ	96.3 LJ	1290	129 LJ	15 LJ	7.6 LJ	14.2 LJ	19.3 LJ	519 U	30.9 LJ	23.4 LJ	520 U	20.5 LJ	475 U	7.4 LJ	175 LJ	954	40.7 LJ	
Manganese	mg/kg	28.2	3.8	12.1	83.4	63.6	1.6	5.2	282	7.2	3.5	2.5	10.3	1.3	3.9	2.1	12.4	1.1 LJ	7.5	2	2.1	8.3	36.3	3.3	
Mercury	mg/kg	0.013 B	0.0066 B	0.0078 B	0.012 B	0.011 LJ	0.0072 LJ	0.0058 LJ	0.0094 LJ	0.0046 LJ	0.11 U	0.1 U	0.1 U	0.1 U	0.095 U	0.005 LJ	0.0093 LJ	0.1 U	0.0073 LJ	0.0053 LJ	0.096 U	0.0077 LJ	0.0046 LJ	0.011 LJ	
Nickel	mg/kg	0.24 B	0.3 B	0.22 B	1.6 B	2.1	0.18 LJ	0.51 U	3.4	0.39 U	0.41 U	0.45 U	0.19 LJ	0.39 U	0.15 LJ	0.24 LJ	0.22 LJ	0.062 LJ	0.46 U	0.35 U	0.4 U	0.38 U	3 J	0.4 UJ	
Potassium	mg/kg	135 B	49.2 B	139 B	675	724	474 U	446 U	1160	423 U	478 U	397 U	378 U	413 U	519 U	429 U	446 U	520 U	368 U	475 U	339 U	408 U	550	464 U	
Selenium	mg/kg	NR	NR	NR	NR	2.5 U	2.6 U	2.6 U	2.3 U	1.9 U	2.1 U	2.3 U	1.8 U	2 U	2.2 U	1.9 U	2.1 U	2.6 U	2.3 U	1.7 U	2 U	1.9 U	2.4 U	2 U	
Silver	mg/kg	NR	NR	NR	NR	0.5 U	0.51 U	0.51 U	0.45 U	0.39 U	0.41 U	0.45 U	0.35 U	0.39 U	0.45 U	0.38 U	0.42 U	0.52 U	0.46 U	0.35 U	0.4 U	0.38 U	0.49 U	0.4 U	
Sodium	mg/kg	NR	NR	NR	373 B	518 U	474 U	446 U	557 U	423 U	478 U	397 U	378 U	413 U	519 U	429 U	446 U	520 U	368 U	475 U	339 U	408 U	442 U	464 U	
Thallium	mg/kg	NR	NR	NR		0.5 U	0.51 U	0.51 U	0.45 U	0.39 U	0.41 U	0.45 U	0.35 U	0.39 U	0.45 U	0.38 U	0.42 U	0.52 U	0.46 U	0.35 U	0.4 U	0.38 U	0.49 U	0.4 U	
Vanadium	mg/kg	1.5 B	0.59 B	0.86 B	4.6 B	7	0.46 LJ	2.6 U	5.7	1.9 U	2.1 U	2.3 U	0.38 LJ	2 U	0.4 LJ	0.55 LJ	2.1 UJ	2.6 UJ	2.3 U	1.7 U	2 U	1.9 U	7.2	2 U	
Zinc	mg/kg	6.4	1.4 B	6.1	12.3	15.8 J	0.4 LJ	1.5 J	7.9 J	2.3 J	0.39 LJ	0.9 UJ	0.59 LJ	0.85 J	0.43 LJ	0.28 LJ	6.9	1 U	3.8 J	0.7 UJ	0.78 LJ	2.3 J	9.2	0.31 LJ	
SEMI-VOLATILE ORGANIC COMPOUNDS (SVOC)																									
Ethyl Ether	mg/kg	0.0061	0.0078	0.0054	0.0068	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
VOLATILE ORGANIC COMPOUNDS (VOC)																									
Acetone	ug/kg	181	413	237	235	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Methylene chloride	ug/kg	131	132	49.1	133	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Qualifiers: U = Not detected J = Indicates an estimated value L = Result is biased low R = Result is unusable NR = No result																									

**TABLE B-4. FALCON REFINERY SUPERFUND SITE - GROUND WATER BACKGROUND DATA  
INGLESIDE, SAN PATRICIO COUNTY, TEXAS**

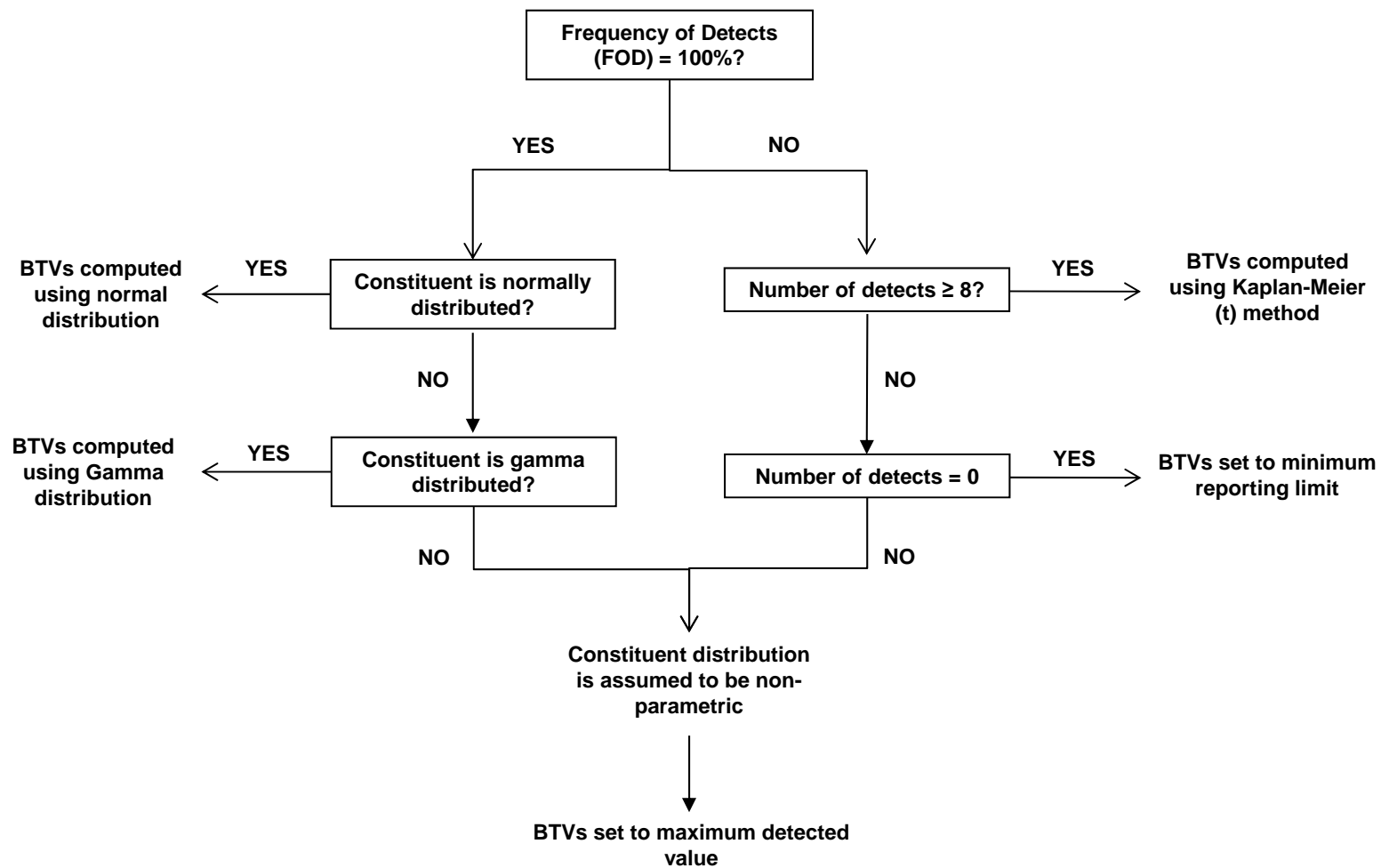
Sample Date:		FR-257	FR-258	FR-261	FR-264	TWB-01	TWB-02 R	TWB-03 R	TWB-04	TWB-04 Dup	TWB-05	TWB-06	TWB-07	TWB-08	TWB-09	TWB-10
Parent Sample Name:										TWB-04						
Sample Depth:																
Date Sampled:		1/16/2008	1/16/2008	1/16/2008	1/16/2008	9/17/2013	9/18/2013	9/17/2013	9/17/2013	9/17/2013	9/17/2013	9/18/2013	9/17/2013	9/17/2013	9/17/2013	9/17/2013
Chemical Name	Unit															
INORGANICS																
Aluminum	ug/L	201	208	153 B	191 B	200 U	1470	498	194 LJ	280	327	200 U	271	1150	513	378
Antimony	ug/L	NR	NR	NR	NR	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U
Arsenic	ug/L	3.6 B	4.9 B	8.3		1.5	3.3	2.5	4	4.1	4.4	4.2	2.3	8.9	16.1	7.8
Barium	ug/L	17.5 B	22.3 B	75.2 B	31.9 B	69.4	179	129	101	104	134	357	51.6	135	80.5	73.3
Beryllium	ug/L	NR	NR	NR	NR	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Cadmium	ug/L	NR	NR	NR	NR	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Calcium	ug/L	130000	132000	154000	104000	113000	106000	25100	42800	43000	62500	54400	52800	24000	22800	25100
Chromium	ug/L	1.7 B	1.5 B	3.6 B	2.5 B	2 U	12.6	2.4	0.97 LJ	1.1 LJ	5	1 U	2.4	2.7	0.65 LJ	0.22 LJ
Chromium, hexavalent	ug/L	NR	NR	6 B	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cobalt	ug/L	NR	NR	NR	NR	1 U	1 U	1 U	1.2 J+	1.3 J+	1 U	1.3 J+	1 U	1.6 J+	2.8	1.1 J+
Copper	ug/L	NR	NR	NR	NR	2 U	59.6	2 U	2 U	2 U	2.2	11	2 U	3.4	2 U	2 U
Iron	ug/L	1980	1980	4370	790	1350	1870	4440	16300	16100	11300	5610	3980	13400	7510	6350
Lead	ug/L			3.9	2.9 B	1 U	3.9	4.3	1 U	1 U	1 U	1 U	1 U	3.4	1.8	1.2
Magnesium	ug/L	6550	6440	114000	44800	10800	27100	17600	41800	41000	48900	20500	20000	13200	13700	11300
Manganese	ug/L	40.1	45.4	1070	331	145	212	91.4	92.3	95.5	183	367	141	136	126	75.7
Mercury	ug/L	NR	NR	NR	NR	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Nickel	ug/L	NR	NR	NR	NR	3.2	10.9	1.3	1.8	1.8	4.2	10.4	1.1	3.4	3.7	1.1
Potassium	ug/L	1030 B	951 B	35400	28200	11500	8880	6110	11200	11400	19200	9600	8980	7800	5440	5000 U
Selenium	ug/L	3.7 B	NR	2.3 B	NR	1.2 LJ	2.7 LJ	5 U	0.19 LJ	5 UJ	2.4 LJ	5 U	5 UJ	5 UJ	5 UJ	5 UJ
Silver	ug/L	NR	NR	NR	NR	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Sodium	ug/L	49600	46500	711000	172000	175000 J	248000 J	99300	267000 J	259000 J	335000 J	100000	109000 J	90500 J	54200 J	70100 J
Thallium	ug/L	NR	NR	NR	NR	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Vanadium	ug/L	1.1 B	1.5 B	4.3 B	1.7 B	5 U	5 U	5 U	5 U	5 U	6.5	5 U	5.5	5 U	5 U	5 U
Zinc	ug/L	10.7 B	12.2 B	12.7 B	NR	3.1 J+	29.9	4.4 J+	2.7 J+	3.7	11.2	15.2	2.9 J+	8.6	2.9 J+	2 U
VOLATILE ORGANIC COMPOUNDS (VOC)																
Toluene	ug/L	0.49 J	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Qualifiers: U = Not detected J = Indicates an estimated value L = Result is biased low R = Result is unusable NR = No result																

**TABLE B-5**  
**SUMMARY OF PROUCL OUTPUTS FOR BACKGROUND RESULTS**  
**AOC-4, FALCON REFINERY SITE**

Analyte	Number of Observations	Number of Detects	Frequency of Detection	Maximum Detected Concentration	Maximum Concentration	Mean of Detected Concentrations	Units	ProUCL UCL Statistics				
								UPL_t	UPL_kmt	UPL_gammaHW	Distribution	Selected UPL
Surface Soil												
1,2,4-Trimethylbenzene	1	1	1	0.0037	0.0037	NA	mg/kg	0	0	0	Not Detected	0.0037
Acetone	3	3	1	0.538	0.538	NA	mg/kg	0	0	0	Not Detected	0.538
Aluminum	15	15	1	10500	10500	3101	mg/kg	7802	0	8418	Gamma	8418
Antimony	12	3	0.25	1.7	1.7	1.097	mg/kg	1.31	1.338	0	Normal	1.7
Arsenic	13	11	0.85	4.6	4.6	1.365	mg/kg	3.495	3.399	0	Gamma	3.399
Barium	15	15	1	1520	1520	291.5	mg/kg	1094	0	1193	Gamma	1193
Beryllium	13	3	0.23	0.44	0.59	0.203	mg/kg	0.408	0.419	0	Normal	0.44
Cadmium	11	1	0.09	0.68	0.68	NA	mg/kg	0	0	0	Not Detected	0.68
Calcium	15	15	1	653000	653000	131134	mg/kg	433705	0	572627	Gamma	572627
Chromium, hexavalent	1	1	1	2.1	2.1	NA	mg/kg	0	0	0	Not Detected	2.1
Cobalt	13	10	0.77	4.8	4.8	1.48	mg/kg	3.461	3.353	0	Gamma	3.353
Copper	15	15	1	39.9	39.9	9.248	mg/kg	26.88	0	28.39	Gamma	28.39
Ethyl Ether	3	3	1	0.0119	0.0119	NA	mg/kg	0	0	0	Not Detected	0.0119
Ethylbenzene	1	1	1	0.0019	0.0019	NA	mg/kg	0	0	0	Not Detected	0.0019
Iron	15	15	1	34500	34500	5819	mg/kg	21349	0	20700	Gamma	20700
Lead	15	15	1	48	48	17.43	mg/kg	41.06	0	50.23	Gamma	50.23
Magnesium	15	15	1	5140	5140	1329	mg/kg	3584	0	4212	Gamma	4212
Manganese	15	15	1	345	345	107.5	mg/kg	271.9	0	326.5	Gamma	326.5
Mercury	15	15	1	0.025	0.025	0.011	mg/kg	0.02	0	0.021	Gamma	0.021
Methylene chloride	3	3	1	0.419	0.419	NA	mg/kg	0	0	0	Not Detected	0.419
Nickel	15	15	1	13.4	13.4	3.937	mg/kg	10.21	0	13.02	Gamma	13.02
Potassium	15	10	0.67	2500	2500	822.8	mg/kg	1728	1698	0	Gamma	1698
Selenium	13	3	0.23	1.3	2.9	1.2	mg/kg	1.522	1.462	0	Nonparametric	1.3
Silver	11	1	0.09	0.11	0.59	NA	mg/kg	0	0	0	Not Detected	0.11
Toluene	1	1	1	0.0017	0.0017	NA	mg/kg	0	0	0	Not Detected	0.0017
Vanadium	15	15	1	23.7	23.7	6.595	mg/kg	17.12	0	19.31	Gamma	19.31
Xylene (total)	1	1	1	0.0071	0.0071	NA	mg/kg	0	0	0	Not Detected	0.0071
Zinc	15	15	1	3630	3630	299		1978	0	973.8	Nonparametric	3630
Subsurface Soil												
Acetone	4	4	1	0.413	0.413	NA	mg/kg	0	0	0	Not Detected	0.413
Aluminum	23	23	1	8990	8990	1341	mg/kg	4772	0	4037	Nonparametric	8990
Arsenic	20	4	0.2	0.99	0.99	0.81	mg/kg	0.784	0.84	0	Normal	0.99
Barium	23	17	0.74	121	121	26.26	mg/kg	78.91	77.67	0	Nonparametric	77.67
Beryllium	20	1	0.05	0.13	0.52	NA	mg/kg	0	0	0	Not Detected	0.13
Calcium	23	12	0.52	61000	61000	12246	mg/kg	35211	34581	0	Gamma	34581
Chromium	23	22	0.96	4.4	4.4	1.046	mg/kg	3.397	3.345	0	Approximate Gamma	3.345
Chromium, hexavalent	3	3	1	3	3	NA	mg/kg	0	0	0	Not Detected	3
Cobalt	20	4	0.2	3.2	3.2	1.65	mg/kg	1.777	1.98	0	Gamma	3.2
Copper	23	13	0.57	3.2	3.2	1.345	mg/kg	2.615	2.6	0	Normal	2.6
Ethyl Ether	4	4	1	0.0078	0.0078	NA	mg/kg	0	0	0	Not Detected	0.0078
Lead	23	23	1	27.3	27.3	3.798	mg/kg	13.5	0	10.97	Approximate Gamma	10.97
Magnesium	23	20	0.87	1290	1290	273.5	mg/kg	1024	993.3	0	Nonparametric	993.3
Mercury	23	16	0.70	0.013	0.11	0.00798	mg/kg	0.0558	0.0126	0	Normal	0.0126
Methylene chloride	4	4	1	0.133	0.133	NA	mg/kg	0	0	0	Not Detected	0.133

**TABLE B-5**  
**SUMMARY OF PROUCL OUTPUTS FOR BACKGROUND RESULTS**  
**AOC-4, FALCON REFINERY SITE**

Analyte	Number of Observations	Number of Detects	Frequency of Detection	Maximum Detected Concentration	Maximum Concentration	Mean of Detected Concentrations	Units	ProUCL UCL Statistics				
								UPL_t	UPL_kmt	UPL_gammaHW	Distribution	Selected UPL
Nickel	23	13	0.57	3.4	3.4	0.916	mg/kg	2.275	2.239	0	Nonparametric	2.239
Potassium	23	7	0.30	1160	1160	490.3	mg/kg	736.4	704.6	0	Normal	1160
Sodium	20	1	0.05	373	557	NA	mg/kg	0	0	0	Not Detected	373
Vanadium	23	11	0.48	7.2	7.2	2.658	mg/kg	5.485	5.374	0	Approximate Gamma	5.374
Zinc	23	20	0.87	15.8	15.8	3.997	mg/kg	11.19	11.02	0	Gamma	11.02
<i>Ground Water - Dissolved</i>												
Aluminum	10	2	0.2	253	253	234	µg/L	236.8	240.7	0	Nonparametric	253
Arsenic	10	10	1	15.7	15.7	5.27	µg/L	13.6	0	14.89	Gamma	14.89
Barium	10	10	1	341	341	125.2	µg/L	285.2	0	292.7	Gamma	292.7
Calcium	10	10	1	123000	123000	56810	µg/L	128722	0	146735	Gamma	146735
Chromium	10	3	0.3	4.8	4.8	2.7	µg/L	3.919	3.774	0	Normal	4.8
Cobalt	10	4	0.4	2.7	2.7	1.725	µg/L	2.416	2.272	0	Normal	2.7
Copper	10	4	0.4	48.2	48.2	18.83	µg/L	38.23	36.74	0	Normal	48.2
Iron	10	9	0.9	17300	17300	7628	µg/L	17945	17235	0	Normal	17235
Magnesium	10	10	1	50200	50200	23100	µg/L	49894	0	53948	Gamma	53948
Manganese	10	10	1	453	453	162.7	µg/L	372	0	366.1	Gamma	366.1
Nickel	10	10	1	14	14	4.73	µg/L	13.39	0	15.16	Gamma	15.16
Potassium	10	9	0.9	17900	17900	9340	µg/L	16596	15748	0	Normal	15748
Selenium	10	1	0.1	5.3	5.3	NA	µg/L	0	0	0	Not Detected	5.3
Sodium	10	10	1	341000	341000	148050	µg/L	333796	0	385888	Normal	333796
Toluene	1	1	1	0.49	0.49	NA	µg/L	0	0	0	Not Detected	0.49
Vanadium	10	1	0.1	5.6	5.6	NA	µg/L	0	0	0	Not Detected	5.6
Zinc	10	8	0.8	23	23	8.55	µg/L	21.42	20.51	0	Approximate Gamma	20.51
<i>Ground Water - Total</i>												
Aluminum	14	12	0.86	1470	1470	470	µg/L	1158	1127	0	Approximate Gamma	1127
Arsenic	13	13	1	16.1	16.1	5.531	µg/L	12.81	0	13.75	Gamma	13.75
Barium	14	14	1	357	357	104.3	µg/L	263.2	0	296.1	Gamma	296.1
Calcium	14	14	1	154000	154000	74907	µg/L	160229	0	193994	Normal	160229
Chromium	14	13	0.93	12.6	12.6	2.875	µg/L	8.435	8.233	0	Gamma	8.233
Chromium, hexavalent	1	1	1	6	6	NA	µg/L	0	0	0	Not Detected	6
Cobalt	10	5	0.5	2.8	2.8	1.62	µg/L	2.494	2.33	0	Normal	2.8
Copper	10	4	0.4	59.6	59.6	19.05	µg/L	43.44	41.79	0	Gamma	59.6
Iron	14	14	1	16300	16300	5802	µg/L	14582	0	17670	Gamma	17670
Lead	12	7	0.58	4.3	4.3	3.057	µg/L	4.931	4.585	0	Normal	4.3
Magnesium	14	14	1	114000	114000	28335	µg/L	80323	0	82556	Gamma	82556
Manganese	14	14	1	1070	1070	218.5	µg/L	701.2	0	658.6	Gamma	658.6
Nickel	11	11	1	11.1	11.1	4.745	µg/L	12.39	0	15.15	Gamma	15.15
Potassium	14	13	0.93	35400	35400	11884	µg/L	29590	29005	0	Gamma	29005
Selenium	12	6	0.5	3.7	5	2.082	µg/L	3.888	4.172	0	Normal	3.7
Sodium	14	14	1	711000	711000	180514	µg/L	504844	0	519610	Gamma	519610
Vanadium	14	6	0.43	6.5	6.5	3.433	µg/L	5.666	5.985	0	Normal	6.5
Zinc	13	12	0.92	29.9	29.9	9.792	µg/L	23.54	22.85	0	Gamma	22.85



Decision Tree for Determining the Background Threshold Value (BTV)

**APPENDIX C**

**PROUCL OUTPUTS**

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## General UCL Statistics for Data Sets with Non-Detects

## User Selected Options

From File Sheet1.wst  
 Full Precision OFF  
 Confidence Coefficient 95%  
 Number of Bootstrap Operations 10000

SS\_Aluminum

## General Statistics

Number of Valid Observations 6

Number of Distinct Observations 6

## Raw Statistics

Minimum 2000  
 Maximum 17000  
 Mean 5170  
 Geometric Mean 3678  
 Median 2940  
 SD 5844  
 Std. Error of Mean 2386  
 Coefficient of Variation 1.13  
 Skewness 2.36

## Log-transformed Statistics

Minimum of Log Data 7.601  
 Maximum of Log Data 9.741  
 Mean of log Data 8.21  
 SD of log Data 0.794

**Warning: A sample size of 'n' = 6 may not adequate enough to compute meaningful and reliable test statistics and estimates!**

**It is suggested to collect at least 8 to 10 observations using these statistical methods!**

**If possible compute and collect Data Quality Objectives (DQO) based sample size and analytical results.**

**Warning: There are only 6 Values in this data**

**Note: It should be noted that even though bootstrap methods may be performed on this data set,  
 the resulting calculations may not be reliable enough to draw conclusions**

**The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.**

## Relevant UCL Statistics

## Normal Distribution Test

Shapiro Wilk Test Statistic 0.611  
 Shapiro Wilk Critical Value 0.788

**Data not Normal at 5% Significance Level**

## Assuming Normal Distribution

95% Student's-t UCL 9978

## 95% UCLs (Adjusted for Skewness)

95% Adjusted-CLT UCL (Chen-1995) 11551  
 95% Modified-t UCL (Johnson-1978) 10361

## Gamma Distribution Test

k star (bias corrected) 0.919  
 Theta Star 5628  
 MLE of Mean 5170  
 MLE of Standard Deviation 5394  
 nu star 11.02  
 Approximate Chi Square Value (.05) 4.591  
 Adjusted Level of Significance 0.0122  
 Adjusted Chi Square Value 3.217

Anderson-Darling Test Statistic 0.897

Anderson-Darling 5% Critical Value 0.707

Kolmogorov-Smirnov Test Statistic 0.358

Kolmogorov-Smirnov 5% Critical Value 0.337

**Data not Gamma Distributed at 5% Significance Level**

## Assuming Gamma Distribution

95% Approximate Gamma UCL (Use when  $n \geq 40$ ) 12414  
 95% Adjusted Gamma UCL (Use when  $n < 40$ ) 17716

## Potential UCL to Use

## Lognormal Distribution Test

Shapiro Wilk Test Statistic 0.78  
 Shapiro Wilk Critical Value 0.788

**Data not Lognormal at 5% Significance Level**

## Assuming Lognormal Distribution

95% H-UCL 17226

95% Chebyshev (MVUE) UCL 11390

97.5% Chebyshev (MVUE) UCL 14267

99% Chebyshev (MVUE) UCL 19919

## Data Distribution

**Data do not follow a Discernable Distribution (0.05)**

## Nonparametric Statistics

95% CLT UCL 9094

95% Jackknife UCL 9978

95% Standard Bootstrap UCL 8796

95% Bootstrap-t UCL 34096

95% Hall's Bootstrap UCL 30866

95% Percentile Bootstrap UCL 9643

95% BCA Bootstrap UCL 10178

95% Chebyshev(Mean, Sd) UCL 15570

97.5% Chebyshev(Mean, Sd) UCL 20069

99% Chebyshev(Mean, Sd) UCL 28909

Use 95% Chebyshev (Mean, Sd) UCL 15570

**Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.**

**These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)**

**and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.**

## General UCL Statistics for Data Sets with Non-Detects

## User Selected Options

From File Sheet1.wst  
 Full Precision OFF  
 Confidence Coefficient 95%  
 Number of Bootstrap Operations 10000

SS\_Arsenic

## General Statistics

Number of Valid Observations 6      Number of Distinct Observations 5

## Raw Statistics

Minimum 0.94  
 Maximum 5.7  
 Mean 2.24  
 Geometric Mean 1.858  
 Median 1.8  
 SD 1.747  
 Std. Error of Mean 0.713  
 Coefficient of Variation 0.78  
 Skewness 2.126

## Log-transformed Statistics

Minimum of Log Data -0.0619  
 Maximum of Log Data 1.74  
 Mean of log Data 0.62  
 SD of log Data 0.624

**Warning: A sample size of 'n' = 6 may not adequate enough to compute meaningful and reliable test statistics and estimates!**

**It is suggested to collect at least 8 to 10 observations using these statistical methods!**

**If possible compute and collect Data Quality Objectives (DQO) based sample size and analytical results.**

**Warning: There are only 6 Values in this data**

**Note: It should be noted that even though bootstrap methods may be performed on this data set,  
 the resulting calculations may not be reliable enough to draw conclusions**

**The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.**

## Relevant UCL Statistics

## Normal Distribution Test

Shapiro Wilk Test Statistic 0.722  
 Shapiro Wilk Critical Value 0.788

**Data not Normal at 5% Significance Level**

## Assuming Normal Distribution

95% Student's-t UCL 3.678

## 95% UCLs (Adjusted for Skewness)

95% Adjusted-CLT UCL (Chen-1995) 4.075  
 95% Modified-t UCL (Johnson-1978) 3.781

## Gamma Distribution Test

k star (bias corrected) 1.526  
 Theta Star 1.468  
 MLE of Mean 2.24  
 MLE of Standard Deviation 1.813  
 nu star 18.32  
 Approximate Chi Square Value (.05) 9.619  
 Adjusted Level of Significance 0.0122  
 Adjusted Chi Square Value 7.455

Anderson-Darling Test Statistic 0.545  
 Anderson-Darling 5% Critical Value 0.702  
 Kolmogorov-Smirnov Test Statistic 0.328  
 Kolmogorov-Smirnov 5% Critical Value 0.335

**Data appear Gamma Distributed at 5% Significance Level**

## Assuming Gamma Distribution

95% Approximate Gamma UCL (Use when  $n \geq 40$ ) 4.265  
 95% Adjusted Gamma UCL (Use when  $n < 40$ ) 5.503

## Potential UCL to Use

## Lognormal Distribution Test

Shapiro Wilk Test Statistic 0.898  
 Shapiro Wilk Critical Value 0.788

**Data appear Lognormal at 5% Significance Level**

## Assuming Lognormal Distribution

95% H-UCL 5.148  
 95% Chebyshev (MVUE) UCL 4.586  
 97.5% Chebyshev (MVUE) UCL 5.629  
 99% Chebyshev (MVUE) UCL 7.676

## Data Distribution

**Data appear Gamma Distributed at 5% Significance Level**

## Nonparametric Statistics

95% CLT UCL 3.413  
 95% Jackknife UCL 3.678  
 95% Standard Bootstrap UCL 3.313  
 95% Bootstrap-t UCL 6.082  
 95% Hall's Bootstrap UCL 8.67  
 95% Percentile Bootstrap UCL 3.54  
 95% BCA Bootstrap UCL 3.85  
 95% Chebyshev(Mean, Sd) UCL 5.35  
 97.5% Chebyshev(Mean, Sd) UCL 6.695  
 99% Chebyshev(Mean, Sd) UCL 9.338

Use 95% Approximate Gamma UCL 4.265

**Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.**

**These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)  
 and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.**

## General UCL Statistics for Data Sets with Non-Detects

## User Selected Options

From File Sheet1.wst  
 Full Precision OFF  
 Confidence Coefficient 95%  
 Number of Bootstrap Operations 10000

SS\_Benzo(a)anthracene

## General Statistics

Number of Valid Observations 6

Number of Distinct Observations 5

## Raw Statistics

Minimum 0.063  
 Maximum 0.59  
 Mean 0.237  
 Geometric Mean 0.157  
 Median 0.1  
 SD 0.237  
 Std. Error of Mean 0.0967  
 Coefficient of Variation 0.998  
 Skewness 1.03

## Log-transformed Statistics

Minimum of Log Data -2.765  
 Maximum of Log Data -0.528  
 Mean of log Data -1.854  
 SD of log Data 0.972

**Warning: A sample size of 'n' = 6 may not adequate enough to compute meaningful and reliable test statistics and estimates!**

**It is suggested to collect at least 8 to 10 observations using these statistical methods!**

**If possible compute and collect Data Quality Objectives (DQO) based sample size and analytical results.**

**Warning: There are only 6 Values in this data**

**Note: It should be noted that even though bootstrap methods may be performed on this data set, the resulting calculations may not be reliable enough to draw conclusions**

**The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.**

## Relevant UCL Statistics

## Normal Distribution Test

Shapiro Wilk Test Statistic 0.733  
 Shapiro Wilk Critical Value 0.788

**Data not Normal at 5% Significance Level**

## Assuming Normal Distribution

95% Student's-t UCL 0.432

## 95% UCLs (Adjusted for Skewness)

95% Adjusted-CLT UCL (Chen-1995) 0.44  
 95% Modified-t UCL (Johnson-1978) 0.439

## Gamma Distribution Test

k star (bias corrected) 0.784  
 Theta Star 0.303  
 MLE of Mean 0.237  
 MLE of Standard Deviation 0.268  
 nu star 9.403  
 Approximate Chi Square Value (.05) 3.572  
 Adjusted Level of Significance 0.0122  
 Adjusted Chi Square Value 2.403

**Data not Gamma Distributed at 5% Significance Level**

## Assuming Gamma Distribution

95% Approximate Gamma UCL (Use when n >= 40) 0.625  
 95% Adjusted Gamma UCL (Use when n < 40) 0.929

## Potential UCL to Use

**Recommended UCL exceeds the maximum observation**

**ProUCL computes and outputs H-statistic based UCLs for historical reasons only.**

**H-statistic often results in unstable (both high and low) values of UCL95 as shown in examples in the Technical Guide.**

**It is therefore recommended to avoid the use of H-statistic based 95% UCLs.**

**Use of nonparametric methods are preferred to compute UCL95 for skewed data sets which do not follow a gamma distribution.**

**Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.**

**These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)**

**and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.**

## Lognormal Distribution Test

Shapiro Wilk Test Statistic 0.799  
 Shapiro Wilk Critical Value 0.788

**Data appear Lognormal at 5% Significance Level**

## Assuming Lognormal Distribution

95% H-UCL 1.444

95% Chebyshev (MVUE) UCL 0.616

97.5% Chebyshev (MVUE) UCL 0.783

99% Chebyshev (MVUE) UCL 1.113

## Data Distribution

**Data appear Lognormal at 5% Significance Level**

## Nonparametric Statistics

95% CLT UCL 0.396

95% Jackknife UCL 0.432

95% Standard Bootstrap UCL 0.382

95% Bootstrap-t UCL 2.474

95% Hall's Bootstrap UCL 2.875

95% Percentile Bootstrap UCL 0.39

95% BCA Bootstrap UCL 0.407

95% Chebyshev(Mean, Sd) UCL 0.659

97.5% Chebyshev(Mean, Sd) UCL 0.841

99% Chebyshev(Mean, Sd) UCL 1.2

Use 95% H-UCL 1.444

## General UCL Statistics for Data Sets with Non-Detects

## User Selected Options

From File Sheet1.wst  
 Full Precision OFF  
 Confidence Coefficient 95%  
 Number of Bootstrap Operations 10000

SS\_Benzo(a)pyrene

## General Statistics

Number of Valid Observations 6      Number of Distinct Observations 6

## Raw Statistics

Minimum 0.053  
 Maximum 0.5  
 Mean 0.224  
 Geometric Mean 0.158  
 Median 0.13  
 SD 0.198  
 Std. Error of Mean 0.0809  
 Coefficient of Variation 0.885  
 Skewness 0.867

## Log-transformed Statistics

Minimum of Log Data -2.937  
 Maximum of Log Data -0.693  
 Mean of log Data -1.846  
 SD of log Data 0.924

**Warning: A sample size of 'n' = 6 may not adequate enough to compute meaningful and reliable test statistics and estimates!**

**It is suggested to collect at least 8 to 10 observations using these statistical methods!**

**If possible compute and collect Data Quality Objectives (DQO) based sample size and analytical results.**

**Warning: There are only 6 Values in this data**

**Note: It should be noted that even though bootstrap methods may be performed on this data set,  
 the resulting calculations may not be reliable enough to draw conclusions**

**The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.**

## Relevant UCL Statistics

## Normal Distribution Test

Shapiro Wilk Test Statistic 0.799  
 Shapiro Wilk Critical Value 0.788

**Data appear Normal at 5% Significance Level**

## Assuming Normal Distribution

95% Student's-t UCL 0.387

## 95% UCLs (Adjusted for Skewness)

95% Adjusted-CLT UCL (Chen-1995) 0.388  
 95% Modified-t UCL (Johnson-1978) 0.392

## Gamma Distribution Test

k star (bias corrected) 0.899  
 Theta Star 0.249  
 MLE of Mean 0.224  
 MLE of Standard Deviation 0.236  
 nu star 10.79  
 Approximate Chi Square Value (.05) 4.439  
 Adjusted Level of Significance 0.0122  
 Adjusted Chi Square Value 3.094

Anderson-Darling Test Statistic 0.473  
 Anderson-Darling 5% Critical Value 0.707  
 Kolmogorov-Smirnov Test Statistic 0.233  
 Kolmogorov-Smirnov 5% Critical Value 0.337

**Data appear Gamma Distributed at 5% Significance Level**

## Assuming Gamma Distribution

95% Approximate Gamma UCL (Use when  $n \geq 40$ ) 0.544  
 95% Adjusted Gamma UCL (Use when  $n < 40$ ) 0.781

## Potential UCL to Use

## Lognormal Distribution Test

Shapiro Wilk Test Statistic 0.904  
 Shapiro Wilk Critical Value 0.788

**Data appear Lognormal at 5% Significance Level**

## Assuming Lognormal Distribution

95% H-UCL 1.185  
 95% Chebyshev (MVUE) UCL 0.581  
 97.5% Chebyshev (MVUE) UCL 0.737  
 99% Chebyshev (MVUE) UCL 1.042

## Data Distribution

**Data appear Normal at 5% Significance Level**

## Nonparametric Statistics

95% CLT UCL 0.357  
 95% Jackknife UCL 0.387  
 95% Standard Bootstrap UCL 0.346  
 95% Bootstrap-t UCL 0.804  
 95% Hall's Bootstrap UCL 1.441  
 95% Percentile Bootstrap UCL 0.352  
 95% BCA Bootstrap UCL 0.361  
 95% Chebyshev(Mean, Sd) UCL 0.577  
 97.5% Chebyshev(Mean, Sd) UCL 0.729  
 99% Chebyshev(Mean, Sd) UCL 1.029

Use 95% Student's-t UCL 0.387

**Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.**

**These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)  
 and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.**

## General UCL Statistics for Data Sets with Non-Detects

## User Selected Options

From File Sheet1.wst  
 Full Precision OFF  
 Confidence Coefficient 95%  
 Number of Bootstrap Operations 10000

SS\_Benzo(b)fluoranthene

## General Statistics

Number of Valid Observations 6      Number of Distinct Observations 6

## Raw Statistics

Minimum 0.1  
 Maximum 0.82  
 Mean 0.39  
 Geometric Mean 0.285  
 Median 0.235  
 SD 0.33  
 Std. Error of Mean 0.135  
 Coefficient of Variation 0.846  
 Skewness 0.854

## Log-transformed Statistics

Minimum of Log Data -2.303  
 Maximum of Log Data -0.198  
 Mean of log Data -1.255  
 SD of log Data 0.871

**Warning: A sample size of 'n' = 6 may not adequate enough to compute meaningful and reliable test statistics and estimates!**

**It is suggested to collect at least 8 to 10 observations using these statistical methods!**

**If possible compute and collect Data Quality Objectives (DQO) based sample size and analytical results.**

**Warning: There are only 6 Values in this data**

**Note: It should be noted that even though bootstrap methods may be performed on this data set,  
 the resulting calculations may not be reliable enough to draw conclusions**

**The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.**

## Relevant UCL Statistics

## Normal Distribution Test

Shapiro Wilk Test Statistic 0.776  
 Shapiro Wilk Critical Value 0.788

**Data not Normal at 5% Significance Level**

## Assuming Normal Distribution

95% Student's-t UCL 0.661

## 95% UCLs (Adjusted for Skewness)

95% Adjusted-CLT UCL (Chen-1995) 0.662  
 95% Modified-t UCL (Johnson-1978) 0.669

## Gamma Distribution Test

k star (bias corrected) 0.983  
 Theta Star 0.397  
 MLE of Mean 0.39  
 MLE of Standard Deviation 0.393  
 nu star 11.8  
 Approximate Chi Square Value (.05) 5.095  
 Adjusted Level of Significance 0.0122  
 Adjusted Chi Square Value 3.628

Anderson-Darling Test Statistic 0.514  
 Anderson-Darling 5% Critical Value 0.706  
 Kolmogorov-Smirnov Test Statistic 0.261  
 Kolmogorov-Smirnov 5% Critical Value 0.337

**Data appear Gamma Distributed at 5% Significance Level**

## Assuming Gamma Distribution

95% Approximate Gamma UCL (Use when n >= 40) 0.903  
 95% Adjusted Gamma UCL (Use when n < 40) 1.268

## Potential UCL to Use

**Recommended UCL exceeds the maximum observation**

## Lognormal Distribution Test

Shapiro Wilk Test Statistic 0.894  
 Shapiro Wilk Critical Value 0.788

**Data appear Lognormal at 5% Significance Level**

## Assuming Lognormal Distribution

95% H-UCL 1.751  
 95% Chebyshev (MVUE) UCL 0.978  
 97.5% Chebyshev (MVUE) UCL 1.234  
 99% Chebyshev (MVUE) UCL 1.738

## Data Distribution

**Data appear Gamma Distributed at 5% Significance Level**

## Nonparametric Statistics

95% CLT UCL 0.611  
 95% Jackknife UCL 0.661  
 95% Standard Bootstrap UCL 0.596  
 95% Bootstrap-t UCL 1.489  
 95% Hall's Bootstrap UCL 2.953  
 95% Percentile Bootstrap UCL 0.603  
 95% BCA Bootstrap UCL 0.612  
 95% Chebyshev(Mean, Sd) UCL 0.977  
 97.5% Chebyshev(Mean, Sd) UCL 1.231  
 99% Chebyshev(Mean, Sd) UCL 1.73

Use 95% Approximate Gamma UCL 0.903

**Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.**

**These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)  
 and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.**

## General UCL Statistics for Data Sets with Non-Detects

## User Selected Options

From File Sheet1.wst  
 Full Precision OFF  
 Confidence Coefficient 95%  
 Number of Bootstrap Operations 10000

SS\_Cobalt

## General Statistics

Number of Valid Observations 6      Number of Distinct Observations 6

## Raw Statistics

Minimum 0.72  
 Maximum 3.8  
 Mean 1.577  
 Geometric Mean 1.32  
 Median 1.195  
 SD 1.157  
 Std. Error of Mean 0.473  
 Coefficient of Variation 0.734  
 Skewness 1.868

## Log-transformed Statistics

Minimum of Log Data -0.329  
 Maximum of Log Data 1.335  
 Mean of log Data 0.277  
 SD of log Data 0.619

**Warning: A sample size of 'n' = 6 may not adequate enough to compute meaningful and reliable test statistics and estimates!**

**It is suggested to collect at least 8 to 10 observations using these statistical methods!**

**If possible compute and collect Data Quality Objectives (DQO) based sample size and analytical results.**

**Warning: There are only 6 Values in this data**

**Note: It should be noted that even though bootstrap methods may be performed on this data set,  
 the resulting calculations may not be reliable enough to draw conclusions**

**The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.**

## Relevant UCL Statistics

## Normal Distribution Test

Shapiro Wilk Test Statistic 0.771  
 Shapiro Wilk Critical Value 0.788

**Data not Normal at 5% Significance Level**

## Assuming Normal Distribution

95% Student's-t UCL 2.529

## 95% UCLs (Adjusted for Skewness)

95% Adjusted-CLT UCL (Chen-1995) 2.739  
 95% Modified-t UCL (Johnson-1978) 2.589

## Gamma Distribution Test

k star (bias corrected) 1.593  
 Theta Star 0.99  
 MLE of Mean 1.577  
 MLE of Standard Deviation 1.249  
 nu star 19.12  
 Approximate Chi Square Value (.05) 10.2  
 Adjusted Level of Significance 0.0122  
 Adjusted Chi Square Value 7.963

Anderson-Darling Test Statistic 0.475  
 Anderson-Darling 5% Critical Value 0.701  
 Kolmogorov-Smirnov Test Statistic 0.257  
 Kolmogorov-Smirnov 5% Critical Value 0.335

**Data appear Gamma Distributed at 5% Significance Level**

## Assuming Gamma Distribution

95% Approximate Gamma UCL (Use when  $n \geq 40$ ) 2.954  
 95% Adjusted Gamma UCL (Use when  $n < 40$ ) 3.786

## Potential UCL to Use

## Lognormal Distribution Test

Shapiro Wilk Test Statistic 0.896  
 Shapiro Wilk Critical Value 0.788

**Data appear Lognormal at 5% Significance Level**

## Assuming Lognormal Distribution

95% H-UCL 3.608

95% Chebyshev (MVUE) UCL 3.236  
 97.5% Chebyshev (MVUE) UCL 3.969  
 99% Chebyshev (MVUE) UCL 5.408

## Data Distribution

**Data appear Gamma Distributed at 5% Significance Level**

## Nonparametric Statistics

95% CLT UCL 2.354  
 95% Jackknife UCL 2.529  
 95% Standard Bootstrap UCL 2.272  
 95% Bootstrap-t UCL 3.523  
 95% Hall's Bootstrap UCL 5.165  
 95% Percentile Bootstrap UCL 2.367  
 95% BCA Bootstrap UCL 2.582  
 95% Chebyshev(Mean, Sd) UCL 3.636  
 97.5% Chebyshev(Mean, Sd) UCL 4.527  
 99% Chebyshev(Mean, Sd) UCL 6.278

Use 95% Approximate Gamma UCL 2.954

**Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.**

**These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)  
 and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.**

## General UCL Statistics for Data Sets with Non-Detects

## User Selected Options

From File	Sheet1.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	10000

SS\_Dibenz(a,h)anthracene

## General Statistics

Number of Valid Data	6	Number of Detected Data	5
Number of Distinct Detected Data	5	Number of Non-Detect Data	1
		Percent Non-Detects	16.67%

## Raw Statistics

Minimum Detected	0.01
Maximum Detected	0.076
Mean of Detected	0.0472
SD of Detected	0.0302
Minimum Non-Detect	0.072
Maximum Non-Detect	0.072

## Log-transformed Statistics

Minimum Detected	-4.605
Maximum Detected	-2.577
Mean of Detected	-3.305
SD of Detected	0.884
Minimum Non-Detect	-2.631
Maximum Non-Detect	-2.631

Warning: There are only 5 Detected Values in this data

Note: It should be noted that even though bootstrap may be performed on this data set  
the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

## UCL Statistics

## Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.878
5% Shapiro Wilk Critical Value	0.762

Data appear Normal at 5% Significance Level

## Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.864
5% Shapiro Wilk Critical Value	0.762

Data appear Lognormal at 5% Significance Level

## Assuming Normal Distribution

DL/2 Substitution Method	
Mean	0.0453
SD	0.0274
95% DL/2 (t) UCL	0.0679

Maximum Likelihood Estimate(MLE) Method

N/A

MLE method failed to converge properly

## Assuming Lognormal Distribution

DL/2 Substitution Method	
Mean	-3.308
SD	0.791
95% H-Stat (DL/2) UCL	0.169

Log ROS Method

Mean in Log Scale	-3.39
SD in Log Scale	0.818
Mean in Original Scale	0.043
SD in Original Scale	0.0289
95% t UCL	0.0668
95% Percentile Bootstrap UCL	0.0608
95% BCA Bootstrap UCL	0.0608
95% H-UCL	0.171

## Gamma Distribution Test with Detected Values Only

k star (bias corrected)	0.988
Theta Star	0.0478
nu star	9.878

A-D Test Statistic	0.421
5% A-D Critical Value	0.684
K-S Test Statistic	0.684
5% K-S Critical Value	0.36

Data appear Gamma Distributed at 5% Significance Level

## Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data

Minimum	0.01
Maximum	0.076
Mean	0.0439
Median	0.0402
SD	0.0282
k star	1.283
Theta star	0.0342
Nu star	15.39
AppChi2	7.534
95% Gamma Approximate UCL (Use when n >= 40)	0.0896
95% Adjusted Gamma UCL (Use when n < 40)	0.119

Note: DL/2 is not a recommended method.

## Data Distribution Test with Detected Values Only

Data appear Normal at 5% Significance Level

## Nonparametric Statistics

Kaplan-Meier (KM) Method	
Mean	0.0441
SD	0.0267
SE of Mean	0.0128
95% KM (t) UCL	0.0698
95% KM (z) UCL	0.0651
95% KM (jackknife) UCL	0.0705
95% KM (bootstrap t) UCL	0.068
95% KM (BCA) UCL	0.0643
95% KM (Percentile Bootstrap) UCL	0.0643
95% KM (Chebyshev) UCL	0.0998
97.5% KM (Chebyshev) UCL	0.124
99% KM (Chebyshev) UCL	0.171

## Potential UCLs to Use

95% KM (t) UCL	0.0698
95% KM (Percentile Bootstrap) UCL	0.0643

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

These recommendations are based upon the results of the simulation studies summarized in Singh, Malchle, and Lee (2006).

For additional insight, the user may want to consult a statistician.

## General UCL Statistics for Data Sets with Non-Detects

## User Selected Options

From File Sheet1.wst  
 Full Precision OFF  
 Confidence Coefficient 95%  
 Number of Bootstrap Operations 10000

SS\_Indeno(1,2,3-cd)pyrene

## General Statistics

Number of Valid Observations 6

Number of Distinct Observations 5

## Raw Statistics

Minimum 0.05  
 Maximum 0.35  
 Mean 0.18  
 Geometric Mean 0.139  
 Median 0.13  
 SD 0.136  
 Std. Error of Mean 0.0556  
 Coefficient of Variation 0.756  
 Skewness 0.706

## Log-transformed Statistics

Minimum of Log Data -2.996  
 Maximum of Log Data -1.05  
 Mean of log Data -1.977  
 SD of log Data 0.81

Warning: A sample size of 'n' = 6 may not adequate enough to compute meaningful and reliable test statistics and estimates!

It is suggested to collect at least 8 to 10 observations using these statistical methods!

If possible compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

Warning: There are only 6 Values in this data

Note: It should be noted that even though bootstrap methods may be performed on this data set,  
 the resulting calculations may not be reliable enough to draw conclusions

The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.

## Relevant UCL Statistics

## Normal Distribution Test

Shapiro Wilk Test Statistic 0.817  
 Shapiro Wilk Critical Value 0.788

Data appear Normal at 5% Significance Level

## Assuming Normal Distribution

95% Student's-t UCL 0.292

## 95% UCLs (Adjusted for Skewness)

95% Adjusted-CLT UCL (Chen-1995) 0.288  
 95% Modified-t UCL (Johnson-1978) 0.295

## Gamma Distribution Test

k star (bias corrected) 1.142  
 Theta Star 0.158  
 MLE of Mean 0.18  
 MLE of Standard Deviation 0.168  
 nu star 13.7  
 Approximate Chi Square Value (.05) 6.369  
 Adjusted Level of Significance 0.0122  
 Adjusted Chi Square Value 4.683

Anderson-Darling Test Statistic 0.403  
 Anderson-Darling 5% Critical Value 0.704  
 Kolmogorov-Smirnov Test Statistic 0.235  
 Kolmogorov-Smirnov 5% Critical Value 0.336  
 Data appear Gamma Distributed at 5% Significance Level

## Assuming Gamma Distribution

95% Approximate Gamma UCL (Use when n >= 40) 0.387  
 95% Adjusted Gamma UCL (Use when n < 40) 0.527

## Potential UCL to Use

## Lognormal Distribution Test

Shapiro Wilk Test Statistic 0.912  
 Shapiro Wilk Critical Value 0.788

Data appear Lognormal at 5% Significance Level

## Assuming Lognormal Distribution

95% H-UCL 0.686

95% Chebyshev (MVUE) UCL 0.438  
 97.5% Chebyshev (MVUE) UCL 0.55  
 99% Chebyshev (MVUE) UCL 0.769

## Data Distribution

Data appear Normal at 5% Significance Level

## Nonparametric Statistics

95% CLT UCL 0.271  
 95% Jackknife UCL 0.292  
 95% Standard Bootstrap UCL 0.262  
 95% Bootstrap-t UCL 0.446  
 95% Hall's Bootstrap UCL 1.042  
 95% Percentile Bootstrap UCL 0.267  
 95% BCA Bootstrap UCL 0.27  
 95% Chebyshev(Mean, Sd) UCL 0.422  
 97.5% Chebyshev(Mean, Sd) UCL 0.527  
 99% Chebyshev(Mean, Sd) UCL 0.733

Use 95% Student's-t UCL 0.292

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)  
 and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

## General UCL Statistics for Data Sets with Non-Detects

## User Selected Options

From File Sheet1.wst  
 Full Precision OFF  
 Confidence Coefficient 95%  
 Number of Bootstrap Operations 10000

SS\_Iron

## General Statistics

Number of Valid Observations 6 Number of Distinct Observations 6

## Raw Statistics

Minimum 2250  
 Maximum 13000  
 Mean 5643  
 Geometric Mean 4681  
 Median 4465  
 SD 4013  
 Std. Error of Mean 1638  
 Coefficient of Variation 0.711  
 Skewness 1.521

## Log-transformed Statistics

Minimum of Log Data 7.719  
 Maximum of Log Data 9.473  
 Mean of log Data 8.451  
 SD of log Data 0.655

**Warning: A sample size of 'n' = 6 may not adequate enough to compute meaningful and reliable test statistics and estimates!**

**It is suggested to collect at least 8 to 10 observations using these statistical methods!**

**If possible compute and collect Data Quality Objectives (DQO) based sample size and analytical results.**

**Warning: There are only 6 Values in this data**

**Note: It should be noted that even though bootstrap methods may be performed on this data set,  
 the resulting calculations may not be reliable enough to draw conclusions**

**The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.**

## Relevant UCL Statistics

## Normal Distribution Test

Shapiro Wilk Test Statistic 0.852  
 Shapiro Wilk Critical Value 0.788

**Data appear Normal at 5% Significance Level**

## Assuming Normal Distribution

95% Student's-t UCL 8945

## 95% UCLs (Adjusted for Skewness)

95% Adjusted-CLT UCL (Chen-1995) 9425  
 95% Modified-t UCL (Johnson-1978) 9114

## Gamma Distribution Test

k star (bias corrected) 1.527  
 Theta Star 3697  
 MLE of Mean 5643  
 MLE of Standard Deviation 4567  
 nu star 18.32  
 Approximate Chi Square Value (.05) 9.622  
 Adjusted Level of Significance 0.0122  
 Adjusted Chi Square Value 7.458

Anderson-Darling Test Statistic 0.271  
 Anderson-Darling 5% Critical Value 0.702  
 Kolmogorov-Smirnov Test Statistic 0.167  
 Kolmogorov-Smirnov 5% Critical Value 0.335

**Data appear Gamma Distributed at 5% Significance Level**

## Assuming Gamma Distribution

95% Approximate Gamma UCL (Use when  $n \geq 40$ ) 10744  
 95% Adjusted Gamma UCL (Use when  $n < 40$ ) 13863

## Potential UCL to Use

## Lognormal Distribution Test

Shapiro Wilk Test Statistic 0.96  
 Shapiro Wilk Critical Value 0.788

**Data appear Lognormal at 5% Significance Level**

## Assuming Lognormal Distribution

95% H-UCL 14126  
 95% Chebyshev (MVUE) UCL 12038  
 97.5% Chebyshev (MVUE) UCL 14836  
 99% Chebyshev (MVUE) UCL 20331

## Data Distribution

**Data appear Normal at 5% Significance Level**

## Nonparametric Statistics

95% CLT UCL 8338  
 95% Jackknife UCL 8945  
 95% Standard Bootstrap UCL 8112  
 95% Bootstrap-t UCL 12242  
 95% Hall's Bootstrap UCL 21240  
 95% Percentile Bootstrap UCL 8363  
 95% BCA Bootstrap UCL 8973  
 95% Chebyshev(Mean, Sd) UCL 12785  
 97.5% Chebyshev(Mean, Sd) UCL 15875  
 99% Chebyshev(Mean, Sd) UCL 21945

Use 95% Student's-t UCL 8945

**Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.**

**These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)  
 and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.**

## General UCL Statistics for Data Sets with Non-Detects

## User Selected Options

From File Sheet1.wst  
 Full Precision OFF  
 Confidence Coefficient 95%  
 Number of Bootstrap Operations 10000

## SS\_Manganese

## General Statistics

Number of Valid Observations 6 Number of Distinct Observations 6

## Raw Statistics

Minimum 65  
 Maximum 259  
 Mean 128.8  
 Geometric Mean 117.1  
 Median 107  
 SD 67.83  
 Std. Error of Mean 27.69  
 Coefficient of Variation 0.527  
 Skewness 1.824

## Log-transformed Statistics

Minimum of Log Data 4.174  
 Maximum of Log Data 5.557  
 Mean of log Data 4.763  
 SD of log Data 0.458

**Warning: A sample size of 'n' = 6 may not adequate enough to compute meaningful and reliable test statistics and estimates!**

**It is suggested to collect at least 8 to 10 observations using these statistical methods!**

**If possible compute and collect Data Quality Objectives (DQO) based sample size and analytical results.**

**Warning: There are only 6 Values in this data**

**Note: It should be noted that even though bootstrap methods may be performed on this data set,  
 the resulting calculations may not be reliable enough to draw conclusions**

**The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.**

## Relevant UCL Statistics

## Normal Distribution Test

Shapiro Wilk Test Statistic 0.803  
 Shapiro Wilk Critical Value 0.788

**Data appear Normal at 5% Significance Level**

## Assuming Normal Distribution

95% Student's-t UCL 184.6

## 95% UCLs (Adjusted for Skewness)

95% Adjusted-CLT UCL (Chen-1995) 196.4  
 95% Modified-t UCL (Johnson-1978) 188

## Gamma Distribution Test

k star (bias corrected) 2.824  
 Theta Star 45.61  
 MLE of Mean 128.8  
 MLE of Standard Deviation 76.65  
 nu star 33.89  
 Approximate Chi Square Value (.05) 21.57  
 Adjusted Level of Significance 0.0122  
 Adjusted Chi Square Value 18.11

Anderson-Darling Test Statistic 0.457  
 Anderson-Darling 5% Critical Value 0.698  
 Kolmogorov-Smirnov Test Statistic 0.266  
 Kolmogorov-Smirnov 5% Critical Value 0.333

**Data appear Gamma Distributed at 5% Significance Level**

## Assuming Gamma Distribution

95% Approximate Gamma UCL (Use when  $n \geq 40$ ) 202.3  
 95% Adjusted Gamma UCL (Use when  $n < 40$ ) 241

## Potential UCL to Use

## Lognormal Distribution Test

Shapiro Wilk Test Statistic 0.924  
 Shapiro Wilk Critical Value 0.788

**Data appear Lognormal at 5% Significance Level**

## Assuming Lognormal Distribution

95% H-UCL 219

95% Chebyshev (MVUE) UCL 231.8  
 97.5% Chebyshev (MVUE) UCL 276.8  
 99% Chebyshev (MVUE) UCL 365.2

## Data Distribution

**Data appear Normal at 5% Significance Level**

## Nonparametric Statistics

95% CLT UCL 174.3  
 95% Jackknife UCL 184.6  
 95% Standard Bootstrap UCL 170.2  
 95% Bootstrap-t UCL 259.7  
 95% Hall's Bootstrap UCL 445  
 95% Percentile Bootstrap UCL 175.7  
 95% BCA Bootstrap UCL 186.6  
 95% Chebyshev(Mean, Sd) UCL 249.5  
 97.5% Chebyshev(Mean, Sd) UCL 301.7  
 99% Chebyshev(Mean, Sd) UCL 404.3

Use 95% Student's-t UCL 184.6

**Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.**

**These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)  
 and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.**

**General UCL Statistics for Data Sets with Non-Detects****User Selected Options**

From File Sheet1.wst  
 Full Precision OFF  
 Confidence Coefficient 95%  
 Number of Bootstrap Operations 10000

**SS\_Mercury****General Statistics**

Number of Valid Observations 6

Number of Distinct Observations 6

**Raw Statistics**

Minimum 0.13  
 Maximum 1.5  
 Mean 0.507  
 Geometric Mean 0.37  
 Median 0.35  
 SD 0.503  
 Std. Error of Mean 0.205  
 Coefficient of Variation 0.992  
 Skewness 2.113

**Log-transformed Statistics**

Minimum of Log Data -2.04  
 Maximum of Log Data 0.405  
 Mean of log Data -0.995  
 SD of log Data 0.827

**Warning: A sample size of 'n' = 6 may not adequate enough to compute meaningful and reliable test statistics and estimates!**

**It is suggested to collect at least 8 to 10 observations using these statistical methods!**

**If possible compute and collect Data Quality Objectives (DQO) based sample size and analytical results.**

**Warning: There are only 6 Values in this data**

**Note: It should be noted that even though bootstrap methods may be performed on this data set,  
 the resulting calculations may not be reliable enough to draw conclusions**

**The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.**

**Relevant UCL Statistics****Normal Distribution Test**

Shapiro Wilk Test Statistic 0.729  
 Shapiro Wilk Critical Value 0.788

**Data not Normal at 5% Significance Level**

**Lognormal Distribution Test**

Shapiro Wilk Test Statistic 0.95  
 Shapiro Wilk Critical Value 0.788

**Data appear Lognormal at 5% Significance Level**

**Assuming Normal Distribution**

95% Student's-t UCL 0.92

**95% UCLs (Adjusted for Skewness)**

95% Adjusted-CLT UCL (Chen-1995) 1.033  
 95% Modified-t UCL (Johnson-1978) 0.95

**Assuming Lognormal Distribution**

95% H-UCL 1.94

95% Chebyshev (MVUE) UCL 1.196  
 97.5% Chebyshev (MVUE) UCL 1.503  
 99% Chebyshev (MVUE) UCL 2.106

**Gamma Distribution Test**

k star (bias corrected) 0.978  
 Theta Star 0.518  
 MLE of Mean 0.507  
 MLE of Standard Deviation 0.512  
 nu star 11.74  
 Approximate Chi Square Value (.05) 5.057  
 Adjusted Level of Significance 0.0122  
 Adjusted Chi Square Value 3.597

Anderson-Darling Test Statistic 0.433  
 Anderson-Darling 5% Critical Value 0.706  
 Kolmogorov-Smirnov Test Statistic 0.27  
 Kolmogorov-Smirnov 5% Critical Value 0.337

**Data appear Gamma Distributed at 5% Significance Level**

**Assuming Gamma Distribution**

95% Approximate Gamma UCL (Use when n >= 40) 1.176  
 95% Adjusted Gamma UCL (Use when n < 40) 1.654

**Potential UCL to Use****Data Distribution**

**Data appear Gamma Distributed at 5% Significance Level**

**Nonparametric Statistics**

95% CLT UCL 0.844  
 95% Jackknife UCL 0.92  
 95% Standard Bootstrap UCL 0.812  
 95% Bootstrap-t UCL 1.688  
 95% Hall's Bootstrap UCL 2.22  
 95% Percentile Bootstrap UCL 0.883  
 95% BCA Bootstrap UCL 0.945  
 95% Chebyshev(Mean, Sd) UCL 1.401  
 97.5% Chebyshev(Mean, Sd) UCL 1.788  
 99% Chebyshev(Mean, Sd) UCL 2.548

Use 95% Approximate Gamma UCL 1.176

**Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.**

**These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)  
 and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.**

**General UCL Statistics for Data Sets with Non-Detects****User Selected Options**

From File Sheet1.wst  
 Full Precision OFF  
 Confidence Coefficient 95%  
 Number of Bootstrap Operations 10000

SB\_Arsenic

**General Statistics**

Number of Valid Observations 12

Number of Distinct Observations 11

**Raw Statistics**

Minimum 0.41  
 Maximum 2.1  
 Mean 1.015  
 Geometric Mean 0.921  
 Median 0.9  
 SD 0.498  
 Std. Error of Mean 0.144  
 Coefficient of Variation 0.49  
 Skewness 1.405

**Log-transformed Statistics**

Minimum of Log Data -0.892  
 Maximum of Log Data 0.742  
 Mean of log Data -0.0827  
 SD of log Data 0.456

**Relevant UCL Statistics****Normal Distribution Test**

Shapiro Wilk Test Statistic 0.798  
 Shapiro Wilk Critical Value 0.859

**Data not Normal at 5% Significance Level****Lognormal Distribution Test**

Shapiro Wilk Test Statistic 0.896  
 Shapiro Wilk Critical Value 0.859

**Data appear Lognormal at 5% Significance Level****Assuming Normal Distribution**

95% Student's-t UCL 1.273

**95% UCLs (Adjusted for Skewness)**

95% Adjusted-CLT UCL (Chen-1995) 1.314  
 95% Modified-t UCL (Johnson-1978) 1.283

**Gamma Distribution Test**

k star (bias corrected) 4.017  
 Theta Star 0.253  
 MLE of Mean 1.015  
 MLE of Standard Deviation 0.506  
 nu star 96.41  
 Approximate Chi Square Value (.05) 74.76  
 Adjusted Level of Significance 0.029  
 Adjusted Chi Square Value 71.86

Anderson-Darling Test Statistic 0.816  
 Anderson-Darling 5% Critical Value 0.732  
 Kolmogorov-Smirnov Test Statistic 0.289  
 Kolmogorov-Smirnov 5% Critical Value 0.246

**Data not Gamma Distributed at 5% Significance Level****Assuming Gamma Distribution**

95% Approximate Gamma UCL (Use when  $n \geq 40$ ) 1.309  
 95% Adjusted Gamma UCL (Use when  $n < 40$ ) 1.362

**Potential UCL to Use****Assuming Lognormal Distribution**

95% H-UCL 1.361  
 95% Chebyshev (MVUE) UCL 1.604  
 97.5% Chebyshev (MVUE) UCL 1.86  
 99% Chebyshev (MVUE) UCL 2.364

**Data Distribution****Data appear Lognormal at 5% Significance Level****Nonparametric Statistics**

95% CLT UCL 1.251  
 95% Jackknife UCL 1.273  
 95% Standard Bootstrap UCL 1.238  
 95% Bootstrap-t UCL 1.54  
 95% Hall's Bootstrap UCL 3.193  
 95% Percentile Bootstrap UCL 1.253  
 95% BCA Bootstrap UCL 1.303  
 95% Chebyshev(Mean, Sd) UCL 1.641  
 97.5% Chebyshev(Mean, Sd) UCL 1.912  
 99% Chebyshev(Mean, Sd) UCL 2.445

Use 95% Student's-t UCL 1.273  
 or 95% Modified-t UCL 1.283  
 or 95% H-UCL 1.361

ProUCL computes and outputs H-statistic based UCLs for historical reasons only.

H-statistic often results in unstable (both high and low) values of UCL95 as shown in examples in the Technical Guide.

It is therefore recommended to avoid the use of H-statistic based 95% UCLs.

Use of nonparametric methods are preferred to compute UCL95 for skewed data sets which do not follow a gamma distribution.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

## General UCL Statistics for Data Sets with Non-Detects

## User Selected Options

From File	Sheet1.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	10000

## SB\_Mercury

## General Statistics

Number of Valid Data	12	Number of Detected Data	11
Number of Distinct Detected Data	11	Number of Non-Detect Data	1
		Percent Non-Detects	8.33%

## Raw Statistics

Minimum Detected	0.006
Maximum Detected	2.3
Mean of Detected	0.258
SD of Detected	0.679
Minimum Non-Detect	0.11
Maximum Non-Detect	0.11

## Log-transformed Statistics

Minimum Detected	-5.116
Maximum Detected	0.833
Mean of Detected	-3.02
SD of Detected	1.657
Minimum Non-Detect	-2.207
Maximum Non-Detect	-2.207

## UCL Statistics

## Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.404
5% Shapiro Wilk Critical Value	0.85

## Data not Normal at 5% Significance Level

## Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.915
5% Shapiro Wilk Critical Value	0.85

## Data appear Lognormal at 5% Significance Level

## Assuming Normal Distribution

DL/2 Substitution Method	
Mean	0.241
SD	0.65
95% DL/2 (t) UCL	0.578

Maximum Likelihood Estimate(MLE) Method N/A

## MLE yields a negative mean

## Assuming Lognormal Distribution

DL/2 Substitution Method	
Mean	-3.01
SD	1.58
95% H-Stat (DL/2) UCL	1.189

Log ROS Method

Mean in Log Scale -3.073

SD in Log Scale 1.59

Mean in Original Scale 0.238

SD in Original Scale 0.651

95% t UCL 0.576

95% Percentile Bootstrap UCL 0.61

95% BCA Bootstrap UCL 0.804

95% H-UCL 1.161

## Gamma Distribution Test with Detected Values Only

k star (bias corrected)	0.349
Theta Star	0.738
nu star	7.673

A-D Test Statistic	1.336
5% A-D Critical Value	0.801
K-S Test Statistic	0.801
5% K-S Critical Value	0.273

## Data not Gamma Distributed at 5% Significance Level

## Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data

Minimum	0.000001
Maximum	2.3
Mean	0.236
Median	0.042
SD	0.652
k star	0.267
Theta star	0.885
Nu star	6.399
AppChi2	1.847

95% Gamma Approximate UCL (Use when n &gt;= 40) 0.818

95% Adjusted Gamma UCL (Use when n &lt; 40) 1.008

Note: DL/2 is not a recommended method.

## Data Distribution Test with Detected Values Only

## Data appear Lognormal at 5% Significance Level

## Nonparametric Statistics

Kaplan-Meier (KM) Method	
Mean	0.239
SD	0.623
SE of Mean	0.189
95% KM (t) UCL	0.578
95% KM (z) UCL	0.549
95% KM (jackknife) UCL	0.576
95% KM (bootstrap t) UCL	4.082
95% KM (BCA) UCL	0.614
95% KM (Percentile Bootstrap) UCL	0.609
95% KM (Chebyshev) UCL	1.061
97.5% KM (Chebyshev) UCL	1.417
99% KM (Chebyshev) UCL	2.116

## Potential UCLs to Use

99% KM (Chebyshev) UCL 2.116

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

For additional insight, the user may want to consult a statistician.

## General UCL Statistics for Data Sets with Non-Detects

## User Selected Options

From File Sheet1.wst  
Full Precision OFF  
Confidence Coefficient 95%  
Number of Bootstrap Operations 10000

## SB\_Benzo(a)anthracene

## General Statistics

Number of Valid Data	11	Number of Detected Data	9
Number of Distinct Detected Data	8	Number of Non-Detect Data	2
		Percent Non-Detects	18.18%

## Raw Statistics

Minimum Detected	0.0045
Maximum Detected	0.23
Mean of Detected	0.0618
SD of Detected	0.084
Minimum Non-Detect	0.0038
Maximum Non-Detect	0.004

## Log-transformed Statistics

Minimum Detected	-5.404
Maximum Detected	-1.47
Mean of Detected	-3.665
SD of Detected	1.427
Minimum Non-Detect	-5.573
Maximum Non-Detect	-5.521

Note: Data have multiple DLs - Use of KM Method is recommended

Number treated as Non-Detect 2

For all methods (except KM, DL/2, and ROS Methods),

Number treated as Detected 9

Observations &lt; Largest ND are treated as NDs

Single DL Non-Detect Percentage 18.18%

**Warning: There are only 9 Detected Values in this data**

**Note: It should be noted that even though bootstrap may be performed on this data set  
the resulting calculations may not be reliable enough to draw conclusions**

**It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.**

## UCL Statistics

## Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.713
5% Shapiro Wilk Critical Value	0.829

**Data not Normal at 5% Significance Level**

## Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.9
5% Shapiro Wilk Critical Value	0.829

**Data appear Lognormal at 5% Significance Level**

## Assuming Normal Distribution

DL/2 Substitution Method	
Mean	0.0509
SD	0.0789
95% DL/2 (t) UCL	0.094
Maximum Likelihood Estimate(MLE) Method	
Mean	0.0409
SD	0.0865
95% MLE (t) UCL	0.0881
95% MLE (Tiku) UCL	0.0871

## Assuming Lognormal Distribution

DL/2 Substitution Method	
Mean	-4.134
SD	1.648
95% H-Stat (DL/2) UCL	0.603
Log ROS Method	
Mean in Log Scale	-4.283
SD in Log Scale	1.876
Mean in Original Scale	0.0507
SD in Original Scale	0.0791
95% t UCL	0.0939
95% Percentile Bootstrap UCL	0.0909
95% BCA Bootstrap UCL	0.104
95% H UCL	1.443

## Gamma Distribution Test with Detected Values Only

k star (bias corrected)	0.533
Theta Star	0.116
nu star	9.585

A-D Test Statistic	0.656
5% A-D Critical Value	0.756
K-S Test Statistic	0.756
5% K-S Critical Value	0.29

**Data appear Gamma Distributed at 5% Significance Level**

## Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data	
Minimum	0.000001
Maximum	0.23
Mean	0.0505
Median	0.0098
SD	0.0792
k star	0.262
Theta star	0.193
Nu star	5.759
AppChi2	1.518
95% Gamma Approximate UCL (Use when n >= 40)	0.192
95% Adjusted Gamma UCL (Use when n < 40)	0.244

**Note: DL/2 is not a recommended method.**

## Data Distribution Test with Detected Values Only

**Data appear Gamma Distributed at 5% Significance Level**

## Nonparametric Statistics

Kaplan-Meier (KM) Method	
Mean	0.0514
SD	0.075
SE of Mean	0.024
95% KM (t) UCL	0.0948
95% KM (z) UCL	0.0908
95% KM (jackknife) UCL	0.0939
95% KM (bootstrap t) UCL	0.212
95% KM (BCA) UCL	0.0942
95% KM (Percentile Bootstrap) UCL	0.0927
95% KM (Chebyshev) UCL	0.156
97.5% KM (Chebyshev) UCL	0.201
99% KM (Chebyshev) UCL	0.29

## Potential UCLs to Use

95% KM (Chebyshev) UCL	0.156
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Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

These recommendations are based upon the results of the simulation studies summarized in Singh, Malchle, and Lee (2006).

For additional insight, the user may want to consult a statistician.

## General UCL Statistics for Data Sets with Non-Detects

## User Selected Options

From File Sheet1.wst  
Full Precision OFF  
Confidence Coefficient 95%  
Number of Bootstrap Operations 10000

SB\_Benzo(a)pyrene

## General Statistics

Number of Valid Data	11	Number of Detected Data	9
Number of Distinct Detected Data	9	Number of Non-Detect Data	2
		Percent Non-Detects	18.18%

## Raw Statistics

Minimum Detected	0.0033
Maximum Detected	0.25
Mean of Detected	0.0604
SD of Detected	0.083
Minimum Non-Detect	0.0038
Maximum Non-Detect	0.004

## Log-transformed Statistics

Minimum Detected	-5.714
Maximum Detected	-1.386
Mean of Detected	-3.664
SD of Detected	1.434
Minimum Non-Detect	-5.573
Maximum Non-Detect	-5.521

Note: Data have multiple DLs - Use of KM Method is recommended

Number treated as Non-Detect 3

For all methods (except KM, DL/2, and ROS Methods),

Number treated as Detected 8

Observations &lt; Largest ND are treated as NDs

Single DL Non-Detect Percentage 27.27%

**Warning: There are only 9 Detected Values in this data**

**Note: It should be noted that even though bootstrap may be performed on this data set  
the resulting calculations may not be reliable enough to draw conclusions**

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

## UCL Statistics

## Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.728
5% Shapiro Wilk Critical Value	0.829

Data not Normal at 5% Significance Level

## Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.964
5% Shapiro Wilk Critical Value	0.829

Data appear Lognormal at 5% Significance Level

## Assuming Normal Distribution

DL/2 Substitution Method	
Mean	0.0497
SD	0.0779
95% DL/2 (t) UCL	0.0923
Maximum Likelihood Estimate(MLE) Method	
Mean	0.0325
SD	0.0931
95% MLE (t) UCL	0.0834
95% MLE (Tiku) UCL	0.0848

## Assuming Lognormal Distribution

DL/2 Substitution Method	
Mean	-4.132
SD	1.653
95% H-Stat (DL/2) UCL	0.617
Log ROS Method	
Mean in Log Scale	-4.118
SD in Log Scale	1.634
Mean in Original Scale	0.0498
SD in Original Scale	0.0779
95% t UCL	0.0924
95% Percentile Bootstrap UCL	0.0893
95% BCA Bootstrap UCL	0.105
95% H UCL	0.577

## Gamma Distribution Test with Detected Values Only

k star (bias corrected)	0.544
Theta Star	0.111
nu star	9.794

A-D Test Statistic	0.403
5% A-D Critical Value	0.755
K-S Test Statistic	0.755
5% K-S Critical Value	0.29

Data appear Gamma Distributed at 5% Significance Level

## Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data	
Minimum	0.000001
Maximum	0.25
Mean	0.0494
Median	0.012
SD	0.0782
k star	0.263
Theta star	0.187
Nu star	5.797
AppChi2	1.537
95% Gamma Approximate UCL (Use when n >= 40)	0.186
95% Adjusted Gamma UCL (Use when n < 40)	0.237

Note: DL/2 is not a recommended method.

## Data Distribution Test with Detected Values Only

Data appear Gamma Distributed at 5% Significance Level

## Nonparametric Statistics

Kaplan-Meier (KM) Method	
Mean	0.05
SD	0.0742
SE of Mean	0.0237
95% KM (t) UCL	0.093
95% KM (z) UCL	0.089
95% KM (jackknife) UCL	0.0921
95% KM (bootstrap t) UCL	0.193
95% KM (BCA) UCL	0.0942
95% KM (Percentile Bootstrap) UCL	0.091
95% KM (Chebyshev) UCL	0.153
97.5% KM (Chebyshev) UCL	0.198
99% KM (Chebyshev) UCL	0.286

## Potential UCLs to Use

95% KM (Chebyshev) UCL	0.153
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Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

These recommendations are based upon the results of the simulation studies summarized in Singh, Malchle, and Lee (2006).

For additional insight, the user may want to consult a statistician.

## General UCL Statistics for Data Sets with Non-Detects

## User Selected Options

From File Sheet1.wst  
Full Precision OFF  
Confidence Coefficient 95%  
Number of Bootstrap Operations 10000

## SB\_Benzo(b)fluoranthene

## General Statistics

Number of Valid Data	11	Number of Detected Data	9
Number of Distinct Detected Data	9	Number of Non-Detect Data	2
		Percent Non-Detects	18.18%

## Raw Statistics

Minimum Detected	0.0048
Maximum Detected	0.28
Mean of Detected	0.0943
SD of Detected	0.109
Minimum Non-Detect	0.0038
Maximum Non-Detect	0.004

## Log-transformed Statistics

Minimum Detected	-5.339
Maximum Detected	-1.273
Mean of Detected	-3.11
SD of Detected	1.417
Minimum Non-Detect	-5.573
Maximum Non-Detect	-5.521

Note: Data have multiple DLs - Use of KM Method is recommended

Number treated as Non-Detect 2

For all methods (except KM, DL/2, and ROS Methods),

Number treated as Detected 9

Observations &lt; Largest ND are treated as NDs

Single DL Non-Detect Percentage 18.18%

**Warning: There are only 9 Detected Values in this data**

**Note: It should be noted that even though bootstrap may be performed on this data set  
the resulting calculations may not be reliable enough to draw conclusions**

**It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.**

## UCL Statistics

## Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.775
5% Shapiro Wilk Critical Value	0.829

**Data not Normal at 5% Significance Level**

## Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.952
5% Shapiro Wilk Critical Value	0.829

**Data appear Lognormal at 5% Significance Level**

## Assuming Normal Distribution

DL/2 Substitution Method	
Mean	0.0775
SD	0.104
95% DL/2 (t) UCL	0.134

## Maximum Likelihood Estimate(MLE) Method

Mean	0.0647
SD	0.115
95% MLE (t) UCL	0.127
95% MLE (Tiku) UCL	0.127

## Assuming Lognormal Distribution

DL/2 Substitution Method	
Mean	-3.679
SD	1.791
95% H-Stat (DL/2) UCL	1.78

## Log ROS Method

Mean in Log Scale	-3.728
SD in Log Scale	1.87
Mean in Original Scale	0.0774
SD in Original Scale	0.104
95% t UCL	0.134
95% Percentile Bootstrap UCL	0.13
95% BCA Bootstrap UCL	0.144
95% H UCL	2.44

## Gamma Distribution Test with Detected Values Only

k star (bias corrected)	0.603
Theta Star	0.156
nu star	10.85

A-D Test Statistic	0.337
5% A-D Critical Value	0.75
K-S Test Statistic	0.75
5% K-S Critical Value	0.289

**Data appear Gamma Distributed at 5% Significance Level**

## Assuming Gamma Distribution

## Gamma ROS Statistics using Extrapolated Data

Minimum	0.000001
Maximum	0.28
Mean	0.0772
Median	0.029
SD	0.104
k star	0.264
Theta star	0.292
Nu star	5.807
AppChi2	1.542
95% Gamma Approximate UCL (Use when n >= 40)	0.291
95% Adjusted Gamma UCL (Use when n < 40)	0.369

**Note: DL/2 is not a recommended method.**

## Data Distribution Test with Detected Values Only

**Data appear Gamma Distributed at 5% Significance Level**

## Nonparametric Statistics

Kaplan-Meier (KM) Method	
Mean	0.078
SD	0.0988
SE of Mean	0.0316
95% KM (t) UCL	0.135
95% KM (z) UCL	0.13
95% KM (jackknife) UCL	0.134
95% KM (bootstrap t) UCL	0.207
95% KM (BCA) UCL	0.134
95% KM (Percentile Bootstrap) UCL	0.131
95% KM (Chebyshev) UCL	0.216
97.5% KM (Chebyshev) UCL	0.275
99% KM (Chebyshev) UCL	0.392

## Potential UCLs to Use

95% KM (Chebyshev) UCL	0.216
------------------------	-------

**Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.****These recommendations are based upon the results of the simulation studies summarized in Singh, Malchle, and Lee (2006).****For additional insight, the user may want to consult a statistician.**

## General UCL Statistics for Data Sets with Non-Detects

## User Selected Options

From File	Sheet1.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	10000

SB\_Dibenz(a,h)anthracene

## General Statistics

Number of Valid Data	11	Number of Detected Data	6
Number of Distinct Detected Data	5	Number of Non-Detect Data	5
		Percent Non-Detects	45.45%

## Raw Statistics

Minimum Detected	0.002
Maximum Detected	0.028
Mean of Detected	0.00963
SD of Detected	0.00962
Minimum Non-Detect	0.0038
Maximum Non-Detect	0.11

## Log-transformed Statistics

Minimum Detected	-6.215
Maximum Detected	-3.576
Mean of Detected	-5.023
SD of Detected	0.953
Minimum Non-Detect	-5.573
Maximum Non-Detect	-2.207

Note: Data have multiple DLs - Use of KM Method is recommended

For all methods (except KM, DL/2, and ROS Methods),

Observations &lt; Largest ND are treated as NDs

Number treated as Non-Detect 11

Number treated as Detected 0

Single DL Non-Detect Percentage 100.00%

**Warning: There are only 6 Detected Values in this data**

**Note: It should be noted that even though bootstrap may be performed on this data set  
the resulting calculations may not be reliable enough to draw conclusions**

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

## UCL Statistics

## Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.79
5% Shapiro Wilk Critical Value	0.788

Data appear Normal at 5% Significance Level

## Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.963
5% Shapiro Wilk Critical Value	0.788

Data appear Lognormal at 5% Significance Level

## Assuming Normal Distribution

DL/2 Substitution Method	
Mean	0.011
SD	0.0165
95% DL/2 (t) UCL	0.02

Maximum Likelihood Estimate(MLE) Method

N/A

MLE method failed to converge properly

## Assuming Lognormal Distribution

DL/2 Substitution Method	
Mean	-5.27
SD	1.193
95% H-Stat (DL/2) UCL	0.0376

Log ROS Method

Mean in Log Scale -5.445

SD in Log Scale 0.859

Mean in Original Scale 0.0065

SD in Original Scale 0.00772

95% t UCL 0.0107

95% Percentile Bootstrap UCL 0.0104

95% BCA Bootstrap UCL 0.0125

95% H-UCL 0.0131

## Gamma Distribution Test with Detected Values Only

k star (bias corrected)	0.841
Theta Star	0.0115
nu star	10.09

A-D Test Statistic 0.315

5% A-D Critical Value 0.708

K-S Test Statistic 0.708

5% K-S Critical Value 0.338

Data appear Gamma Distributed at 5% Significance Level

## Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data

Minimum	0.000001
Maximum	0.028
Mean	0.00619
Median	0.00314
SD	0.00801
k star	0.437
Theta star	0.0142
Nu star	9.619
AppChi2	3.705
95% Gamma Approximate UCL (Use when n >= 40)	0.0161
95% Adjusted Gamma UCL (Use when n < 40)	0.019

Note: DL/2 is not a recommended method.

## Data Distribution Test with Detected Values Only

Data appear Normal at 5% Significance Level

## Nonparametric Statistics

Kaplan-Meier (KM) Method

Mean 0.0068

SD 0.00765

SE of Mean 0.00266

95% KM (t) UCL 0.0116

95% KM (z) UCL 0.0112

95% KM (jackknife) UCL 0.0115

95% KM (bootstrap t) UCL 0.0175

95% KM (BCA) UCL 0.0125

95% KM (Percentile Bootstrap) UCL 0.0118

95% KM (Chebyshev) UCL 0.0184

97.5% KM (Chebyshev) UCL 0.0234

99% KM (Chebyshev) UCL 0.0332

## Potential UCLs to Use

95% KM (t) UCL 0.0116

95% KM (Percentile Bootstrap) UCL 0.0118

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

These recommendations are based upon the results of the simulation studies summarized in Singh, Malchle, and Lee (2006).

For additional insight, the user may want to consult a statistician.

## General UCL Statistics for Data Sets with Non-Detects

## User Selected Options

From File Sheet1.wst  
Full Precision OFF  
Confidence Coefficient 95%  
Number of Bootstrap Operations 10000

SB\_Indeno(1,2,3-cd)pyrene

## General Statistics

Number of Valid Data	11	Number of Detected Data	9
Number of Distinct Detected Data	9	Number of Non-Detect Data	2
		Percent Non-Detects	18.18%

## Raw Statistics

Minimum Detected	0.0025
Maximum Detected	0.2
Mean of Detected	0.0499
SD of Detected	0.0641
Minimum Non-Detect	0.0038
Maximum Non-Detect	0.004

## Log-transformed Statistics

Minimum Detected	-5.991
Maximum Detected	-1.609
Mean of Detected	-3.759
SD of Detected	1.401
Minimum Non-Detect	-5.573
Maximum Non-Detect	-5.521

Note: Data have multiple DLs - Use of KM Method is recommended

Number treated as Non-Detect 3

For all methods (except KM, DL/2, and ROS Methods),

Number treated as Detected 8

Observations &lt; Largest ND are treated as NDs

Single DL Non-Detect Percentage 27.27%

**Warning: There are only 9 Detected Values in this data**

**Note: It should be noted that even though bootstrap may be performed on this data set  
the resulting calculations may not be reliable enough to draw conclusions**

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

## UCL Statistics

## Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.754
5% Shapiro Wilk Critical Value	0.829

Data not Normal at 5% Significance Level

## Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.986
5% Shapiro Wilk Critical Value	0.829

Data appear Lognormal at 5% Significance Level

## Assuming Normal Distribution

DL/2 Substitution Method	
Mean	0.0412
SD	0.0605
95% DL/2 (t) UCL	0.0743

## Maximum Likelihood Estimate(MLE) Method

Mean	0.0281
SD	0.0723
95% MLE (t) UCL	0.0677
95% MLE (Tiku) UCL	0.0688

## Assuming Lognormal Distribution

DL/2 Substitution Method	
Mean	-4.21
SD	1.605
95% H-Stat (DL/2) UCL	0.469

## Log ROS Method

Mean in Log Scale	-4.209
SD in Log Scale	1.603
Mean in Original Scale	0.0412
SD in Original Scale	0.0605
95% t UCL	0.0743
95% Percentile Bootstrap UCL	0.0718
95% BCA Bootstrap UCL	0.0851
95% H UCL	0.465

## Gamma Distribution Test with Detected Values Only

k star (bias corrected)	0.595
Theta Star	0.0839
nu star	10.71

A-D Test Statistic	0.227
5% A-D Critical Value	0.75
K-S Test Statistic	0.75
5% K-S Critical Value	0.289

Data appear Gamma Distributed at 5% Significance Level

## Assuming Gamma Distribution

## Gamma ROS Statistics using Extrapolated Data

Minimum	0.000001
Maximum	0.2
Mean	0.0408
Median	0.016
SD	0.0608
k star	0.272
Theta star	0.15
Nu star	5.976
AppChi2	1.627

95% Gamma Approximate UCL (Use when n &gt;= 40)

0.15

95% Adjusted Gamma UCL (Use when n &lt; 40)

0.19

Note: DL/2 is not a recommended method.

## Data Distribution Test with Detected Values Only

Data appear Gamma Distributed at 5% Significance Level

## Nonparametric Statistics

Kaplan-Meier (KM) Method	
Mean	0.0413
SD	0.0576
SE of Mean	0.0184
95% KM (t) UCL	0.0747
95% KM (z) UCL	0.0716
95% KM (jackknife) UCL	0.074
95% KM (bootstrap t) UCL	0.132
95% KM (BCA) UCL	0.0755
95% KM (Percentile Bootstrap) UCL	0.0729
95% KM (Chebyshev) UCL	0.122
97.5% KM (Chebyshev) UCL	0.156
99% KM (Chebyshev) UCL	0.225

## Potential UCLs to Use

95% KM (Chebyshev) UCL 0.122

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

These recommendations are based upon the results of the simulation studies summarized in Singh, Malchle, and Lee (2006).

For additional insight, the user may want to consult a statistician.

**APPENDIX D**

**CONSTRUCTION WORKER  
PARTICULATE EMISSION FACTOR**

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# Site-specific

## Construction Worker Equation Inputs for Soil - Other than Standard Vehicle Traffic

1

Variable	Value
TR (target cancer risk) unitless	1.0E-6
THQ (target hazard quotient) unitless	1
AT <sub>CW</sub> (averaging time - construction worker)	365
EF <sub>CW</sub> (exposure frequency - construction worker) day/yr	250
ED <sub>CW</sub> (exposure duration - construction worker) yr	1
ET <sub>CW</sub> (exposure time - construction worker) hr	8
LT (lifetime) yr	70
BW <sub>CW</sub> (body weight - construction worker) kg	70
IR <sub>CW</sub> (soil ingestion rate - construction worker) mg/day	330
SA <sub>CW</sub> (surface area - construction worker) cm <sup>2</sup> /day	3300
AF <sub>CW</sub> (skin adherence factor - construction worker) mg/cm <sup>2</sup>	0.3
A <sub>fill</sub> (areal extent of tilling) acres	1.7
A <sub>excav</sub> (area of excavation site) m <sup>2</sup>	1.7
A <sub>C-grade</sub> (area of grading) acres	1.7
A <sub>C-grade</sub> (area of dozing) acres	1.7
A <sub>surf</sub> (areal extent of site) m <sup>2</sup>	2023.43
M <sub>m-doz</sub> (Gravimetric soil moisture content) %	7.9
M <sub>m-excav</sub> (Gravimetric soil moisture content) %	12
&rho; <sub>soil</sub> (density) g/cm <sup>3</sup> - chemical-specific	1.68
N <sub>A-dump</sub> (number of times soil is dumped)	2
N <sub>A-fill</sub> (number of times soil is tilled)	2
s <sub>fill</sub> (soil silt content) %	18
s <sub>dnoz</sub> (soil silt content) %	6.9
B <sub>i</sub> (dozing blade length) m	12
B <sub>i</sub> (grading blade length) m	12
N (number of times site was dozed)	2
N (number of times site was graded)	1
S (dozing speed) kph	6.9
S (dozing speed) kph	11.4
d <sub>excav</sub> (average depth of excavation site) m	1.5

# Site-specific

2

## Construction Worker Equation Inputs for Soil - Other than Standard Vehicle Traffic

Variable	Value
T (time over which construction occurs) s	7200000
$J_T$ (g/m <sup>2</sup> s)	0.0000041285792
F(x) (function dependant on $U_m/U_t$ derived using Cowherd et al. (1985))	0.194
$U_t$ (equivalent threshold value) m/s	11.32
$U_m$ (mean annual wind speed) m/s	4.69
V (fraction of vegetative cover)	0
$M_{wind}$ (dust emitted by wind erosion) g	51288.84717
$M_{doz}$ (dust emitted from dozing operations) g	34.071833870843
$M_{till}$ (dust emitted from tilling operations) g	8573.7005230242
$M_{grade}$ (dust emitted from grading operations) g	250.35130512000
$M_{excav}$ (dust emitted from excavation soil dumping) g	1.0447946612478
&Sigma;VKT <sub>doz</sub> (sum of fleet vehicle km traveled) km	1.1466500000000
&Sigma;VKT <sub>grade</sub> (sum of fleet vehicle km traveled) km	0.5733250000000
Q/C <sub>eq</sub> (inverse of the ratio of the geometric mean air concentration to the emission flu	14.31407
PEF <sub>sc</sub> (particulate emission factor) m <sup>3</sup> /kg	18656485.799800
A (PEF Dispersion Constant)	2.4538
B (PEF Dispersion Constant)	17.5660
C (PEF Dispersion Constant)	189.0426
T (temperature) &deg;C	25
foc (fraction organic carbon in soil) g/g	0.006
&rho; <sub>b</sub> (dry soil bulk density) g/cm <sup>3</sup>	1.5
&rho; <sub>s</sub> (soil particle density) g/cm <sup>3</sup>	2.65
A (VF Dispersion Constant)	2.4538
B (VF Dispersion Constant)	17.5660
C (VF Dispersion Constant)	189.0426
T (exposure interval) s	31536000
Q/C <sub>eq</sub> (inverse of the ratio of the geometric mean air concentration to the emission flu	14.31407
n (total soil porosity) L <sub>pore</sub> /L <sub>soil</sub>	0.43396
&theta; <sub>w</sub> (water-filled soil porosity) L <sub>water</sub> /L <sub>soil</sub>	0.15
&theta; <sub>a</sub> (air-filled soil porosity) L <sub>air</sub> /L <sub>soil</sub>	0.28396

# Site-specific

3

## Construction Worker Screening Levels (RSL) for Soil - Other than Standard Vehicle Traffic

ca=Cancer, nc=Noncancer, ca\* (Where nc SL < 100 x ca SL),  
 ca\*\* (Where nc SL < 10 x ca SL), max=SL exceeds ceiling limit (see User's Guide), sat=SL exceeds csat,  
 Smax=Soil SL exceeds ceiling limit and has been substituted with the max value (see User's Guide),  
 Ssat=Soil inhalation SL exceeds csat and has been substituted with the csat

Chemical	CAS Number	Mutagen?	VOC?	Ingestion SF (mg/kg-day) <sup>-1</sup>	SFO Ref	Inhalation Unit Risk (ug/m <sup>3</sup> ) <sup>-1</sup>	IUR Ref	Subchronic RfD (mg/kg-day)	SRfD Ref	Subchronic RfC (mg/m <sup>3</sup> )	SRfC Ref	GIABS	ABS	RBA	Volatilization Factor (m <sup>3</sup> /kg)
Arsenic, Inorganic	7440-38-2	No	No	1.50E+00	I	4.30E-03	I	-		-		1	0.03	0.6	-
Benzo[a]pyrene	50-32-8	Yes	No	7.30E+00	I	1.10E-03	C	-		-		1	0.13	1	-
Benzo[b]fluoranthene	205-99-2	Yes	No	7.30E-01	W	1.10E-04	C	-		-		1	0.13	1	-

Chemical	Soil Saturation Concentration (mg/kg)	Apparent Diffusivity (cm <sup>2</sup> /s)	D <sub>ia</sub> (cm <sup>2</sup> /s)	D <sub>iw</sub> (cm <sup>2</sup> /s)	Henry's law constant	K <sub>d</sub> (cm <sup>3</sup> /g)	K <sub>oc</sub> (cm <sup>3</sup> /g)
Arsenic, Inorganic	-	-	-	-	-	29	-
Benzo[a]pyrene	-	-	0.0475831	5.5597E-6	0.0000187	-	587400
Benzo[b]fluoranthene	-	-	0.0475831	5.5597E-6	0.0000269	-	599400

Chemical	Particulate Emission Factor (m <sup>3</sup> /kg)	Ingestion SL TR=1.0E-6 (mg/kg)	Dermal SL TR=1.0E-6 (mg/kg)	Inhalation SL TR=1.0E-6 (mg/kg)	Carcinogenic SL TR=1.0E-6 (mg/kg)	Ingestion SL HQ=1 (mg/kg)	Dermal SL HQ=1 (mg/kg)	Inhalation SL HQ=1 (mg/kg)	Noncarcinogenic SL HI=1 (mg/kg)	Screening Level (mg/kg)
Arsenic, Inorganic	1.87E+07	2.41E+01	1.61E+02	1.33E+03	2.06E+01	1.55E+02	1.03E+03	1.23E+03	1.21E+02	2.06E+01 ca**
Benzo[a]pyrene	1.87E+07	2.97E+00	7.61E+00	5.20E+03	2.14E+00	-	-	-	-	2.14E+00 ca
Benzo[b]fluoranthene	1.87E+07	2.97E+01	7.61E+01	5.20E+04	2.14E+01	-	-	-	-	2.14E+01 ca